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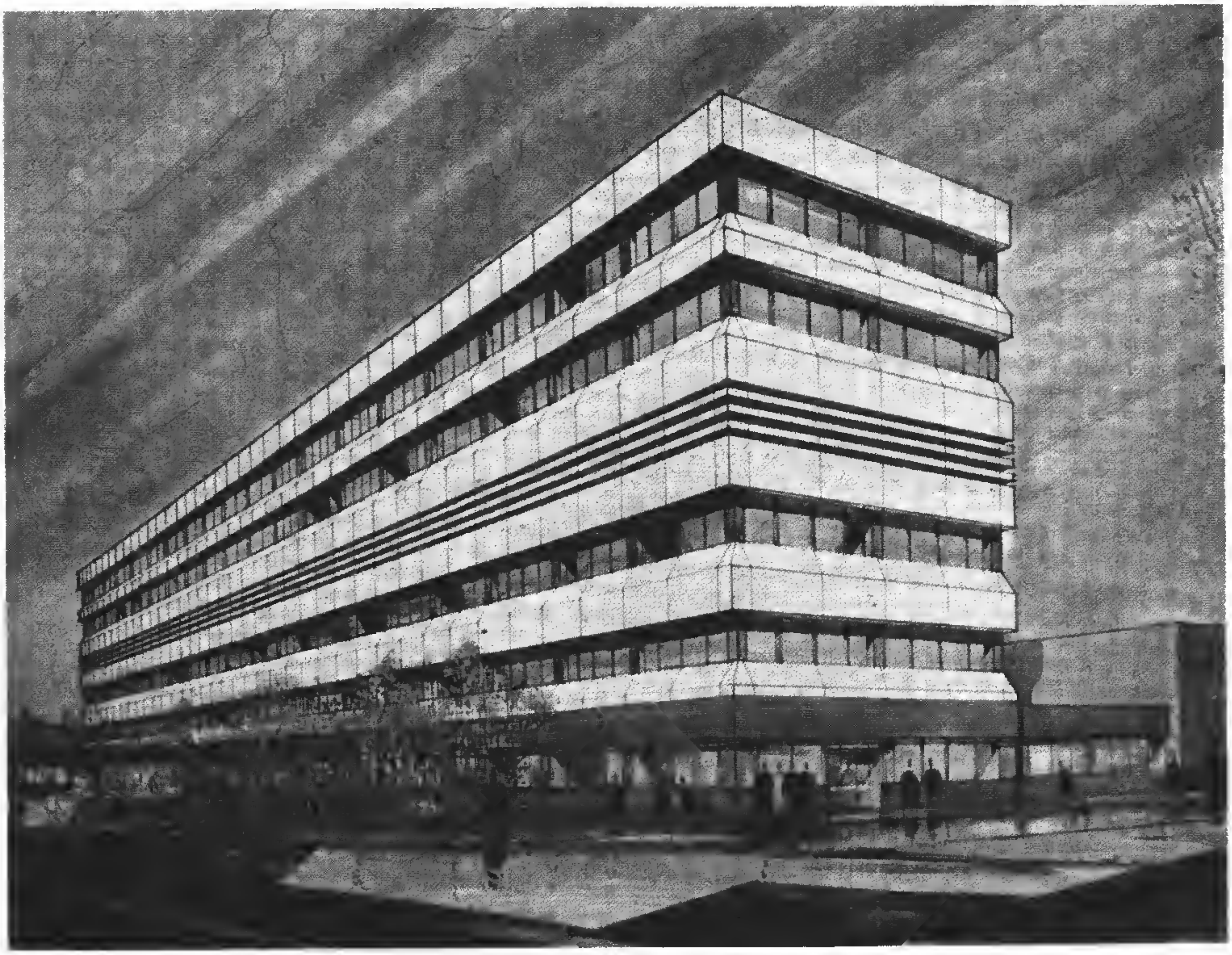

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The cover illustration is an artist's impression of New Broadcasting House Manchester

Editorial

Engineering Developments in Regional Broadcasting

In 1962, at the time of the Pilkington Report, the BBC Regions were six in number, Scotland, Wales, Northern Ireland, North of England, Midlands and West of England. Division of the English regions was possible to give sub-regions such as Northeast England, East Anglia and South-west England. All the regional centres had facilities for radio and television, the former being usually in purpose-built or properly adapted premises. Television, in comparison, occupied a variety of makeshift accommodation, some of it usable only when an outside broadcast vehicle was driven in to operate there. Even so, from such premises the Regions began (in 1962) to broadcast regional television programmes of some twenty minutes duration with news broadcasts and topical magazines to replace the ten-minute bulletins which had been broadcast hitherto.

In July 1969 the BBC published 'Broadcasting in the Seventies', which contained plans for network radio and non-metropolitan broadcasting during the next decade, and in 'BBC Engineering' number 87, July 1971 the engineering aspects of the BBC plans were reviewed and descriptions given of the first of the purpose-built Network Production Centres, Pebble Mill in Birmingham. This issue takes the story another significant step along the road of regional development by describing the second new Network Production Centre, in Manchester. During the intervening four years, however, there have been other steps, albeit smaller ones, at the Regional television stations in England, and these are described here in order to complete the picture.

Fig. 1 Broadcasting House, Plymouth

Fig. 2 Plymouth colour television studio

Fig. 3 Leeds: new television premises

Fig. 4 Leeds colour television studio: production gallery

There are now eight Regional Television Stations in England covering the following regions:

North East (Newcastle)	Midland (Birmingham)
North (Leeds)	South (Southampton)
North West (Manchester)	West (Bristol)
East, formerly East Anglia (Norwich)	South West (Plymouth)

These Regional stations originate a nightly News magazine programme of twenty-five minutes duration on each weekday, a weekly half-hour general interest programme and a short sports programme on Saturdays. In 1976 this output will be increased with the addition of a second weekly half-hour programme. These programmes are provided on an 'opt-out' basis on BBC-1 for viewers within the appropriate editorial boundaries. On occasions, because of a wider interest, some of the weekly programmes are re-broadcast on a national basis, e.g. on BBC-2. The stations also provide facilities for contributions to National news as required.

The stations at Manchester, Birmingham and Bristol are an integral part of the Network Production Centres as far as the engineering aspects are concerned, and are equipped with full colour facilities. At the other five stations the development programme has been based on the need to colourise the output as soon as resources permitted, and wherever possible at the same time to provide bigger studios to meet the increasing programme requirements.

At three stations, Newcastle, Southampton and Norwich, the original studios are still in use, but have been refurbished with the installation of the colour equipment, viz. colour cameras, colour telecine, colour processing and colour video tape. The provision of larger studios in purpose-built premises at these stations must await the acquisition and development of new sites.

At two stations, Plymouth and Leeds, it has been possible to introduce full colour operation in modern purpose-built premises. The original premises in Plymouth were destroyed in an air raid during the Second World War and the house shown in Figure 1 was bought as a replacement. An extension to this building now houses a colour television studio and all its ancillary areas such as control and apparatus rooms, telecine and video tape, colour film processing and film cutting room.

The studio (Figure 2) has an area of 140 m^2 and is equipped with two pedestal-mounted colour cameras; a third is available. The lighting installation has a maximum capacity of 75 kW and uses luminaires suspended on pantographs from trolleys which run on horizontal scaffold tracks. A presentation annexe to the studio has simple sound and vision cutting facilities and means of inserting the locally-originated programmes when 'opting-out' the local transmitters from the BBC-1 network.

A single acoustically-treated room adjoining the studio houses the production control area as well as all the vision and sound apparatus and a maintenance position. Equipment bays form a partition between the production control area and the rest of the room.

At Leeds, in a completely new building (Figure 3) the installation is the same in essentials to that at Plymouth. The studio is similar in size, with 100 kW lighting capacity and three colour cameras. The production gallery (Figure 4) is at first-floor level and there are separate apparatus and maintenance rooms.

This very brief account merely summarises a story of continuous development which, starting from Pebble Mill, has progressed through Plymouth and Leeds and the other English regional centres, to Manchester. The situation now is that the changes set out in 'Broadcasting in the Seventies' have been largely achieved.

Acoustic Scaling in the Design of a Large Music Studio*

H.D. Harwood, K.E. Randall, K.F.L. Lansdowne

Research Department

Summary: The technique of acoustic scaling has been successfully applied to the design of a large music studio for the BBC's new Manchester Headquarters

A scale model of the proposed design was built and twelve different combinations of acoustic treatment and ceiling height were tested subjectively and objectively. As a result of these tests an earlier finding that moderate variations of height do not produce significant acoustic changes has been confirmed; a preferred reverberation time (2.25 seconds) substantially longer than that which established practice would suggest (about 1.8 seconds) has been found and is now recommended by the acoustic consultants.† The ability to carry out listening tests has been invaluable in producing a design which not only gives better sound quality than a more traditional arrangement but which should also cost substantially less for acoustic treatment.

During the course of the work anomalies in existing methods of measuring high absorption coefficients at frequencies below 250Hz have been discovered. They are to be investigated further.

1 Introduction

The design of a large music studio is a little easier than that of a concert hall because the nature of the reproduced sound can be influenced after construction by the choice of microphone characteristics and positions. The quality of the output, however, is still governed by many of the same laws as govern quality in the concert hall and these laws are as yet poorly understood. Consequently the empirical approach of basing designs on past experience and modifying the acoustic treatment on the basis of listening tests has much to commend it. It can, however, be inordinately expensive, particularly when a large studio might require extensive alterations to the acoustic treatment or even structural modifications.

An approach to the problem which permits listening tests to be carried out before the studio is built is therefore very attractive. Such a method is acoustic scaling or modelling, in which a one-eighth scale model of the proposed studio is built and tested by reproducing in it, at eight times normal speed, recordings of music made in non-reverberant surroundings; this produces eight times the normal frequencies and hence one-eighth the normal wavelengths, so that the ratio of obstacle size to wavelength is the same as in normal conditions and therefore reflection and diffraction effects should be identical with those in the normal-sized studio. Microphones in the model pick up the programme for recording on tape moving at the same high speed, and when this tape is replayed at normal speed the result is a good approximation to the output which would have been obtained from the full-size studio if it had been built. Any scale factor is possible in principle but one-eighth is a suitable value in terms of convenience of modelling and performance of tape machines, loudspeakers and microphones. The method has been tested and validated in a series of experiments which have been reported earlier.[1]

This paper is concerned with the application of acoustic scaling to the design of a large music studio for the BBC's new Manchester Headquarters. In the event, the deterioration of the BBC's financial position has so far prevented the building of the studio but the design is ready for better times.

2 Studio design considerations

The basic design requirements for this studio were that it should be large enough to hold the BBC Northern Symphony Orchestra (of about 70 members), that a wide shallow layout for the orchestra was preferred, and that this layout should be capable of facing either along or across the studio to allow space for other performers when required. An audience of 200 would be present on some occasions.

These requirements favoured a roughly square floor plan although an exactly square arrangement was clearly to be avoided on acoustic grounds: a width of nearly 22 metres was chosen together with a length of 26 metres. The height

*This article is based on BBC Research Reports RD 1975/11 and RD 1975/35: Acoustic scaling: the design of a large music studio for Manchester (Interim and Final Reports respectively).
†Sandy Brown Associates.

was left to be decided by experiment but a value of 13 to 15 metres was envisaged.

Vertical diffusing ribs were to be attached to the walls, irregularly spaced to avoid any risk of colouration of the reflected sound.[2] A coffered ceiling was proposed for the same reason. Modular absorbers were to be mounted in the coffering and between the ribs. The absorbers were to be irregularly positioned and of several sizes in order to help maintain adequate diffusion and yield the desired reverberation time.

3 Construction of model studio

The shell of the model was made of 25 mm (one inch) Laminboard which was given three coats of hard polyurethane lacquer. To avoid unwanted sound absorption at high frequencies in the model, extremely dry air was circulated through holes in the ceiling and walls, corresponding to those to be used for ventilation in the real studio: in choosing the positions for the absorbers care was taken to leave areas free for ventilation and lighting fittings. The appearance of the model is shown in Figure 1.

During earlier work with a model of Maida Vale No. 1 studio[3,4] the scaled reverberation time has been temporarily raised to 2.2 seconds and the resulting sound quality had been judged to be better than that with the normal reverberation time of about 1.9 seconds. The value originally contemplated for the new Manchester studio was about 1.5 seconds but as a result of these findings the design figure was raised to a value of 1.9 seconds for frequencies up to 1 kHz with an orchestra of seventy players but no choir or audience, falling to 1.5 seconds at 8 kHz because of inevitable air absorption.

4 Design of model absorbers

In planning the studio it was intended to use modular absorbers similar to those employed in existing studios[5] but of different sizes and shapes. As these changes would alter the areas of the individual absorbers, the variation of absorption with frequency might well be affected and it was therefore necessary to measure the properties of some full-size modular absorbers in order to know just what properties were needed for the model versions.

A number of full-size absorbers were constructed and their absorption coefficients were measured in the large

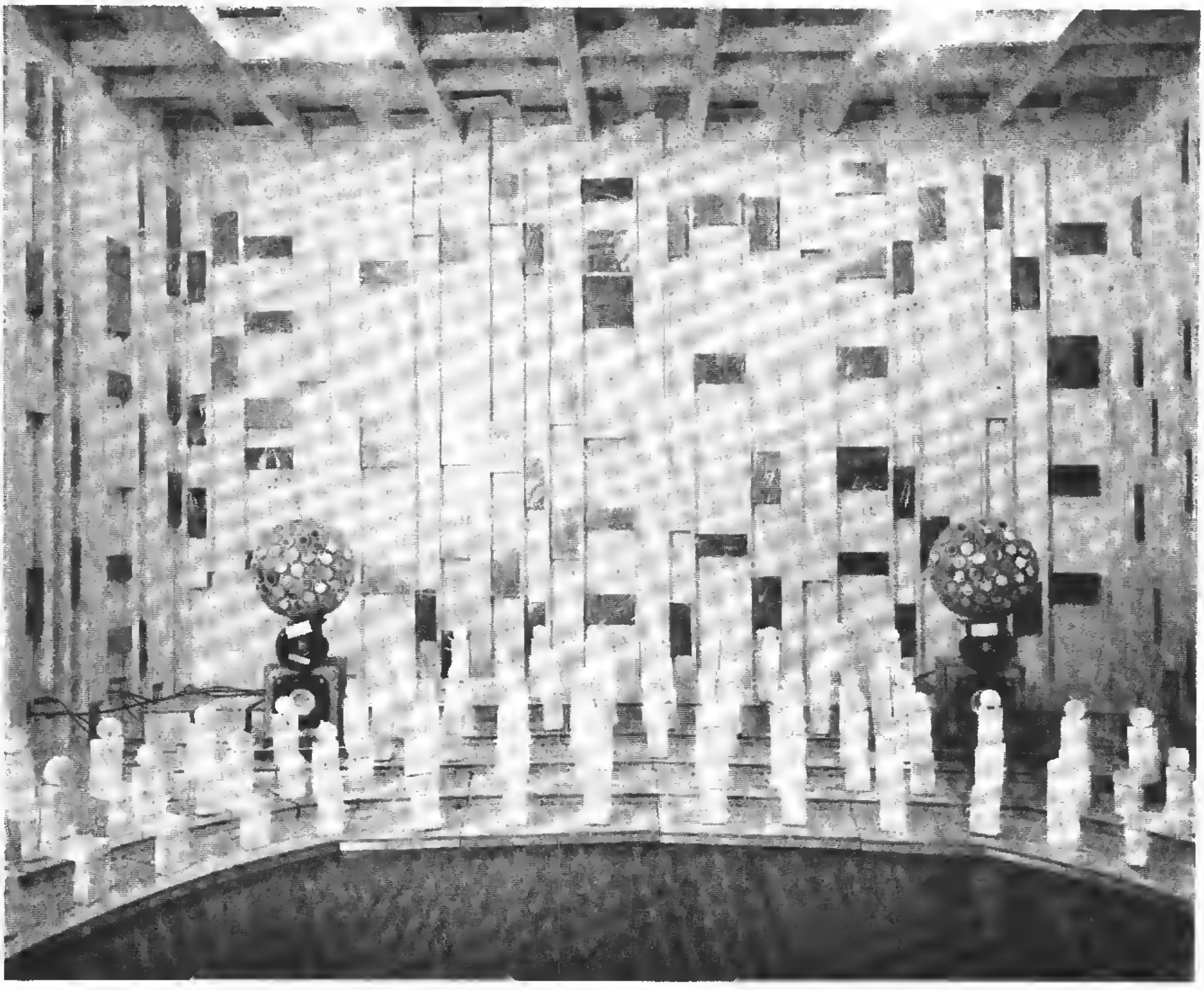

Fig. 1 Appearance of model

reverberation room at the BBC Research Department (volume 106m³). Their properties were found to be satisfactory at middle and high frequencies, but there was an unexplained discrepancy below 250 kHz compared with the design data. In addition to the two standard types of absorber the new studio design called for a further type which was intended to absorb down to lower frequencies than before and with this also difficulty was experienced in getting satisfactory results. Although the large reverberation room could not be guaranteed for low-frequency work, it had always been believed to be reasonably satisfactory: these measurements raised doubts about its suitability at low frequencies.

Concurrently, work was proceeding on the model absorbers and there was no difficulty in producing a wideband modular absorber in the model reverberation room, which was made to scaled ISO standards, (scaled volume equivalent to 200m³), ie, scaled to a room larger than the large reverberation room at the Research Department. When the bass absorbers were tested, however, more difficulties arose, some of which were traced to the position of the samples in the reverberation room.

In order to avoid these problems the empty shell of the model studio was used as the scaled equivalent of an extremely large reverberation room. Considerable differences were discovered between the measurements in the shell of the model studio and those in the model reverberation room at frequencies below 2 kHz (equivalent to 250 Hz). The scaled ISO-size room had been supposed to be suitable for use at least down to 1 kHz but it appears that it is not so for highly absorbing materials. This matter is being further investigated with full-sized absorbers. Meanwhile, the results obtained in the model studio were taken as correct.

Even these results, however, were not straightforward. The diffusing ribs mounted on the walls and the coffering of the ceiling were both found to affect considerably the properties of the absorbers, and separate measurements with modules on each surface were found to be necessary. Surprisingly, the frequency range most affected is the bass. The diffusing effect of the ribs and coffering is less for longer wavelengths and greater for shorter ones and thus was expected to affect the absorption of the modules mainly in the treble range. These results illustrate the advantage of modelling: this bass effect was quite unknown and would have required considerable modification if encountered for the first time in the real studio.

For the model wide-band absorbers the perforated fronts were made of a standard brass material with a 25 per cent open-to-closed ratio, ie, the same as in the full-size absorbers, and with holes and thickness of material also closely scaling the full-size items. For the narrow-band and bass absorbers, a rigid pvc sheet was specially perforated for the purpose and although the hole size was larger than the true scale size, the open/closed ratio was accurate and they functioned correctly. The absorbing material was 6 mm felt for the wide-band absorber and baize for the narrow-band and bass absorbers; in each case the absorbing material was supported on a rigid paper honeycomb with a cell size closely modelling the cardboard partitions used in full-size versions. The construction is illustrated in Figure 2.

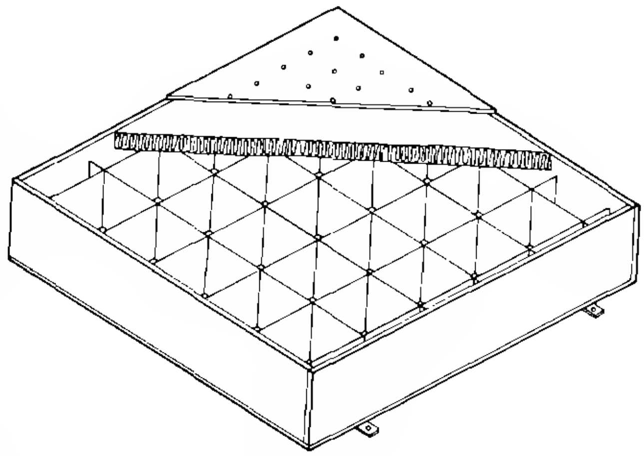

Fig. 2 Construction of full size modular absorber

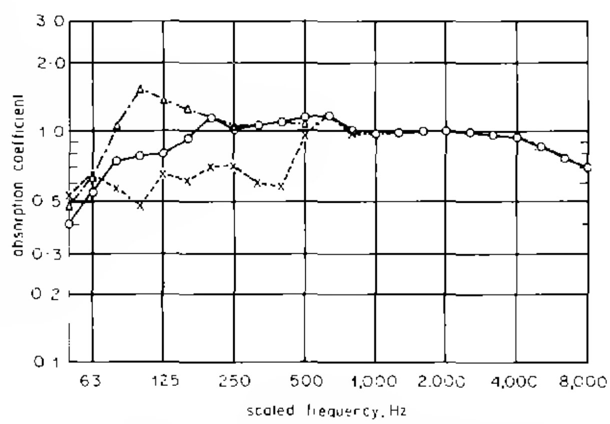

Fig. 3 Scaled absorption coefficient of wideband modular absorber scattered randomly for various conditions

o ——— o on walls

X - - - X On ceiling

Δ — - — Δ On floor

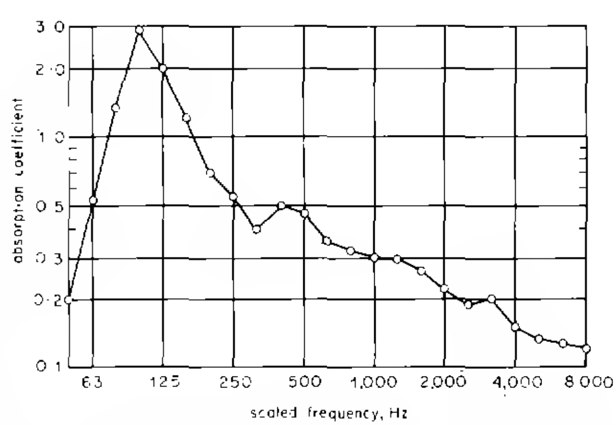

Fig. 4 Scaled absorption coefficient of narrow band modular absorber scattered randomly

The scaled absorption coefficients of the various modules are shown in Figures 3, 4 and 5. The unexpected degree to which the wide-band modules absorb sound at the lower end of the frequency band made the narrow-band absorbers, with an absorption peak centred at 100 Hz, unnecessary and the design proceeded using the bass and wide-band units only. This simplification should result in a considerable saving in cost.

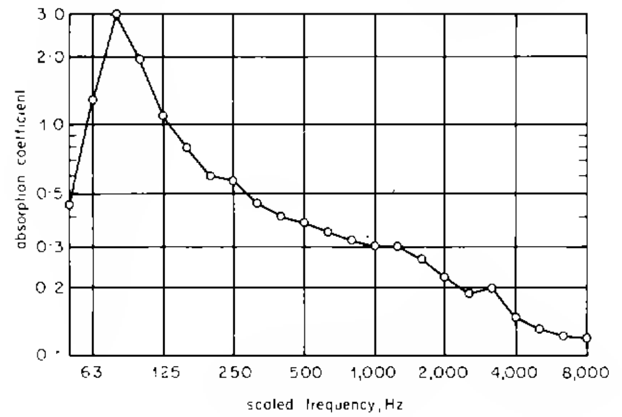

Fig. 5 Scaled absorption coefficient of bass absorber scattered randomly

5 Reverberation time

Figure 6 shows the scaled reverberation time obtained in the model for a height of 13.7 metres (45 ft). It is clear that the results are close to the planned value over most of the frequency range, but that the curve at high frequencies falls a little below the target. Air absorption at these frequencies is largely responsible for this as may be seen from Figure 7, which shows reverberation time curves for various degrees of treatment of the model.

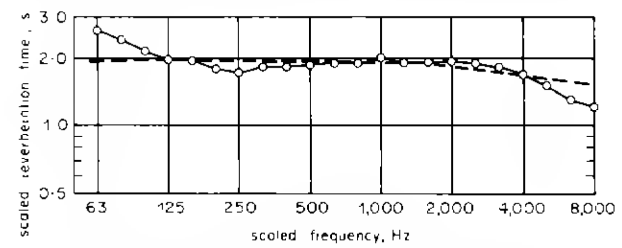

Fig. 6 Scaled reverberation time on model studio for height of 13.7 metres and original acoustic treatment

o —— o Measures
– – – – – Design objective

Recordings using 'dry' programme[1] were made in the model under the conditions of Figure 6 and used for listening tests by a number of staff intimately concerned with the project. The general tonal quality was judged to be good but the reverberation time at high frequencies was considered slightly short.

Experiments were therefore carried out to reduce further the absorption coefficient of the wide-band modules in this frequency range. Two alternative approaches were possible: the first was to change the ratio of open-to-closed area of the perforated front plate of the absorbers to a lower value, the second was to cover the front plate with a very thin non-porous layer. It was not possible in the time available to find a suitable material for the first scheme, so the second was chosen. The fronts of the absorbers were covered with a loose layer of Melinex 0.006 mm (0.00025 in) thick: the absorption coefficient under these conditions is shown in Figure 8 and it is clear that the use of these absorbers could

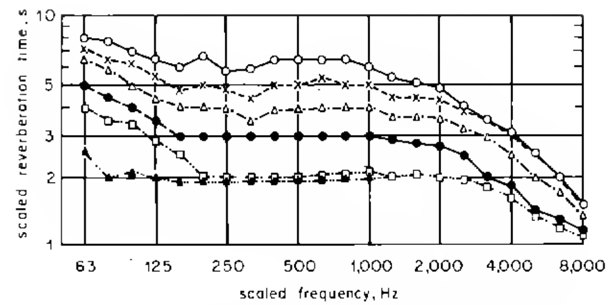

Fig. 7 Scaled reverberation time in model studio for height of 13.7 metres and various degrees of acoustic treatment

o —— o No additional treatment
x - - - x ⅛ No. of wide-band absorbers
Δ —— · —— Δ ¼ No. of wide-band absorbers
• —— —— —— • ½ No. of wide-band absorbers
□ —— · · —— □ Total complement of wide-band absorbers
▲ —— · · · —— ▲ Total complement of all absorbers

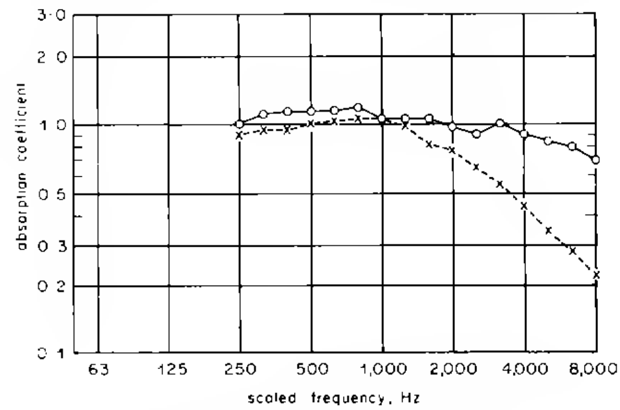

Fig. 8 Effect on scaled absorption coefficient of wide-band absorber of cover of loose 0.006 mm Melinex

o —— o Absorption coefficient, normal design
x - - - x Absorption coefficient, with Melinex

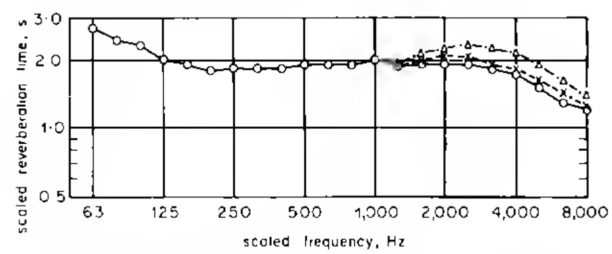

Fig. 9 Scaled reverberation time in model studio for height of 13.7 metres, wideband absorbers bare, 50% and 100% covered with loose 0.006 mm Melinex

o —— o All absorbers bare
x · · · x 50% wideband absorbers covered with Melinex
Δ —— • —— Δ 100% wideband absorbers covered with Melinex

raise the reverberation time in the desired frequency range.

As a first step only half of the wide-band absorbers in the model were covered and the scaled reverberation time obtained in this way is shown in Figure 9, together with that from Figure 6. The value measured at 2.5 kHz became somewhat too high, but that at 8 kHz was slightly nearer the design value. Preliminary listening tests using the model in this condition revealed a slight improvement of the sound quality.

Another experiment was therefore carried out in which all the wide-band absorbers were covered with Melinex. The reverberation curve for the new condition is also shown in Figure 9: the excess value at 2.5 kHz had become marked, whereas the improvement at 8 kHz was still quite small. In further listening tests some observers regarded the quality as slightly too hard and brilliant.

These three sets of recordings suggested that there was no point in pursuing the original intention and examining the effects of increasing the height of the studio by 2 metres (6 ft). Instead attention was turned to investigating the effects of reducing the height by a similar amount.

Reverberation time measurements were made in the model with a lower ceiling and the results are shown in Figure 10. Listening tests revealed no appreciable change in

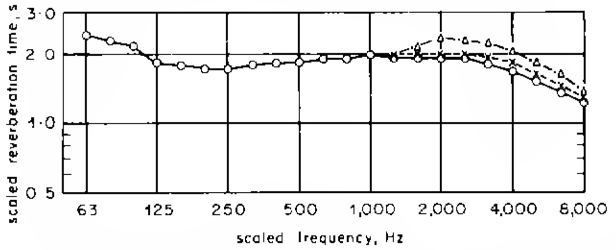

Fig. 10 Scaled reverberation time in model studio for height of 12.2 metres, wideband absorbers bare. 50% and 100% covered with loose 0 006 mm Melinex

o —— o All absorbers bare
x - - - x 50% wideband absorbers covered with Melinex
Δ —— - —— Δ 100% wideband absorbers covered with Melinex

the sound quality due to the reduction of height. This result was in accordance with expectations based on previous experience with the model of the Maida Vale No. 1 studio.[3,4]

6 Subjective tests

In order to assess more accurately the subjective effects of the various changes which had been made to the model, it was necessary to make tests employing a large number of observers. A tape was prepared in which each of the conditions was compared with that having a height of 13.7 metres (45 ft) and with half of the absorbers covered with Melinex; this serves as a convenient standard. Each comparison lasted for about five minutes and sections of the Mozart and Malcolm Arnold recordings[1] were used as well as staccato chords. The technique of interlacing the two conditions on an 'ABAB' basis[6] was employed together with a test recording in which the standard was compared with itself as a check on the acuity of the subject.

The team of observers consisted of staff who are normally responsible for the sound quality of programmes and Research Department staff accustomed to making critical subjective assessments: about 36 persons in all.

Observers commented on the similarity of the six conditions presented and stated that all were probably satisfactory: the total variation in mean gradings between conditions was only ±0.5 in a situation which allows ±5 as the extremes of the subjective scale. There was no significant preference for either height, which was expected, but there was a slight preference for the longest reverberation time at high frequencies; ie, for the condition in which all the wideband absorbers were covered with Melinex.

Table 1 shows the mean overall preferences for all the observers. Some of the differences are too small to be statistically significant so that the six conditions can be grouped in three pairs as shown. It should again be emphasised that the difference even between the extremes is very small. Negative gradings indicate a preference for the test condition and positive ones a preference for the reference standard.

TABLE 1

Order of Preference	1		2		3	
Mean grading	−0.6	−0.6	−0.2	−0.2	0.3	0.5
Roof height	13.7m (45ft)	12.2m (40ft)	13.7m (45ft)	13.7m (45ft)	12.2m (40ft)	12.2m (40ft)
Proportion of wide-band absorbers covered in Melinex	All	All	Half	None	None	Half

The lack of a preference for either height means that this factor can be decided on other grounds. The slight preference for longer reverberation times, however, suggested that the optimum time might be longer still.

Recordings with scaled mid-band reverberation times of 2.25, 2.5 and 2.75 seconds were therefore made with the object of testing higher values as well as lower ones than the optimum in order to establish its position more clearly. Both ceiling heights were used.

7 Further subjective tests

The reverberation time/frequency curves actually obtained for these six conditions are shown in Figures 11 and 12. As expected, there is a progressive relative falling off at high frequencies as the mid-band figure is increased, in spite of the use of the Melinex film on the model absorbers.

The new series of listening tests also used the method of 'ABAB' comparison of the test recording B with an arbitrary standard A. The standard chosen was the recording obtained with 2.25 seconds reverberation time at an equivalent height of 12.2 metres (40 ft); this represents a convenient intermediate condition. Six conditions are the most that

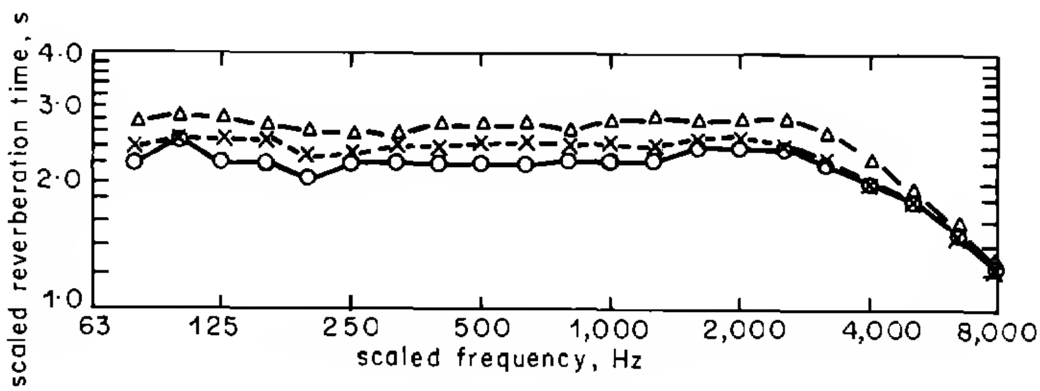

Fig. 11 Reverberation time/frequency curves for proposed Manchester music studio. Height 12 metres.

o —— o 2.25 sec

x --- x 2.5 sec

Δ — - — Δ 2.75 sec

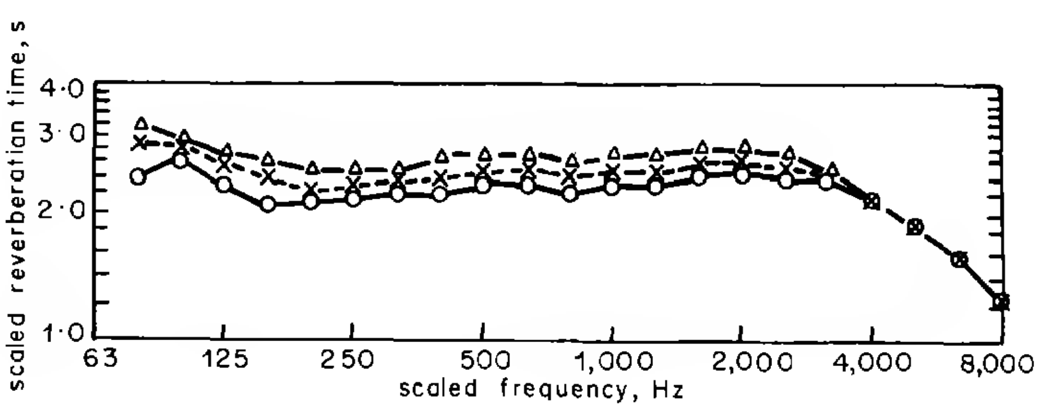

Fig. 12 Reverberation time/frequency curves for proposed Manchester music studio. Height 14 metres.

o —— o 2.25 sec

x --- x 2 5 sec

Δ — - — Δ 2 35 sec

subjects can be asked to compare in one session without undue fatigue, and consequent loss of discrimination, even with a break of 15 minutes in the middle of the test. This means that not all the conditions recorded could be assessed if any of the former conditions were to be included. The test conditions chosen were

(a) 1.9 seconds at 12.2 metres height
(b) 2.25 seconds at 12.2 metres height (acuity check)
(c) 2.25 seconds at 13.7 metres height
(d) 2.5 seconds at 13.7 metres height
(e) 2.5 seconds at 12.2 metres height
(f) 2.75 seconds at 13.7 metres height.

The microphone placing was the same for all recordings and it follows, therefore, that the recordings with the longer reverberation times have a perspective different from those with the shorter reverberation times. The questionnaire asked for an assessment of the sound quality of the test recording B relative to that of the standard A, but in some cases observers stated that in fact they had gone further than this and assessed the potential sound quality which they predicted would have been obtained, had they been permitted to re-position the microphones to give the optimum sound balance.

TABLE 2

Summary of Overall Assessments for Six Comparisons

Test	1	2	3	4	5	6
Mid-frequency reverberation time (secs.)	2.75	1.9	2.25	2.5	2.25	2.5
Roof height	13.7m (45ft)	12.2m (40ft)	12.2m (40ft)	13.7m (45ft)	13.7m (45ft)	12.2m (40ft)
	All observers (n = 27)					
Mean grading	0.122	0.467	−0.422	−0.200	−0.022	−0.193
Standard error	0.212	0.216	0.178	0.225	0.154	0.227
	All consistent observers (n = 15)					
Mean grading	0.233	0.713	−0.040	−0.273	0.060	0.007
Standard error	0.248	0.254	0.029	0.290	0.195	0.267

8 Results

The results are given in Table 2 both for all observers and for the fifteen who passed the acuity test, ie, they gave scores of zero or near to zero in comparison No. 3 and gave scores exceeding ±0.5 on at least some of the other comparisons.

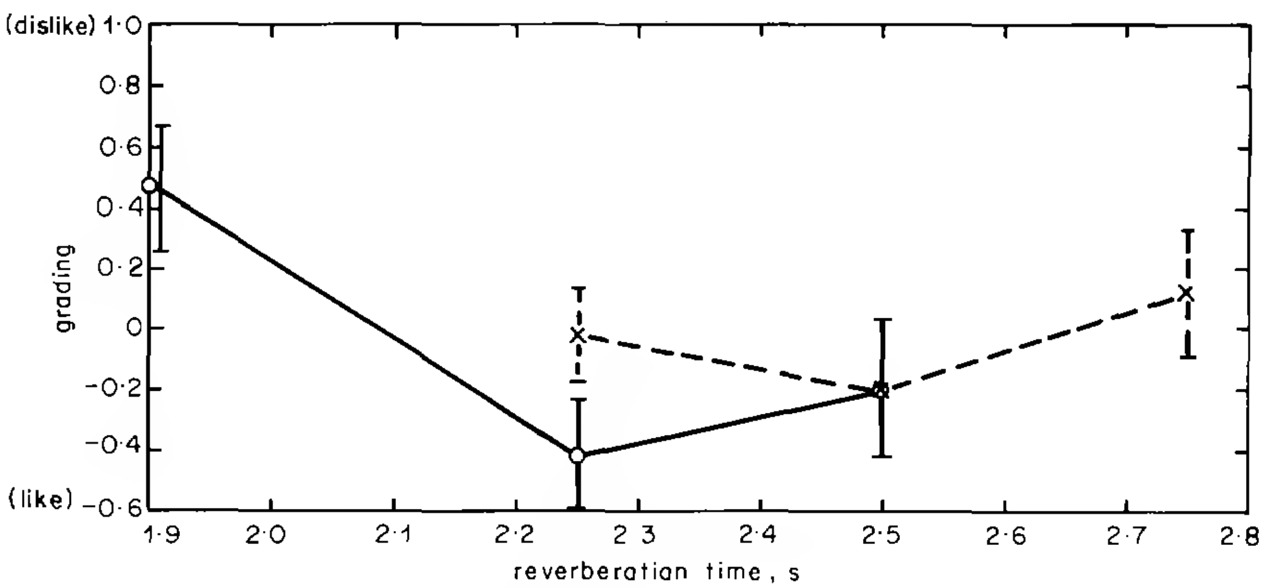

Fig. 13 Subjective overall ratings for proposed Manchester music studio. All observers.

o 12 metres

x 14 metres

Standard error 12 metres

Standard error 14 metres

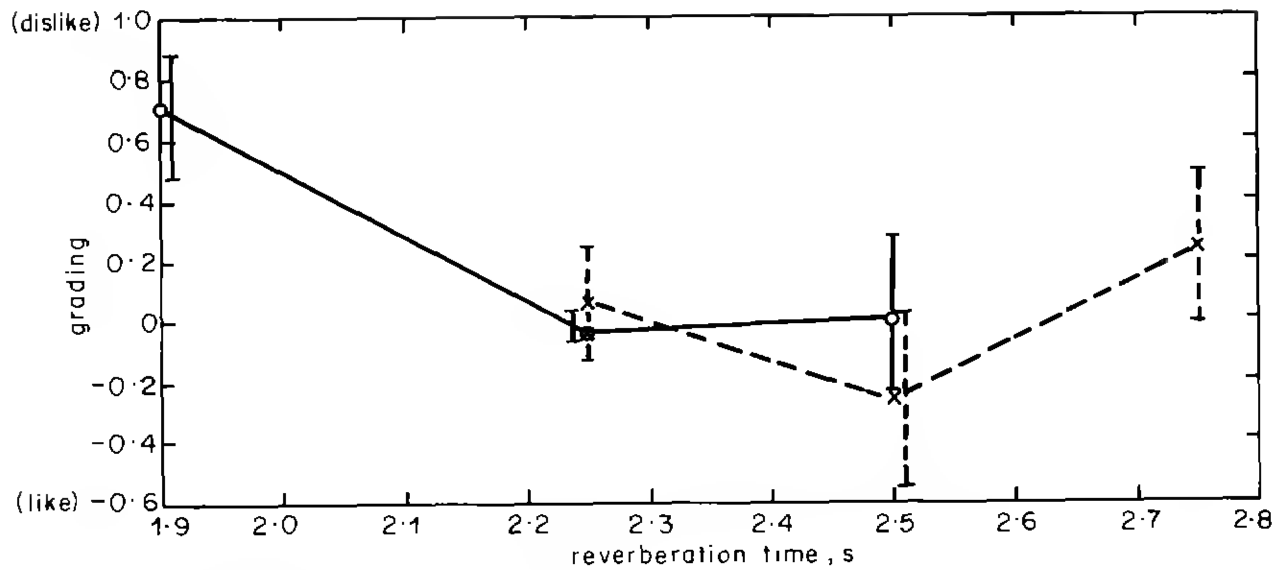

Fig. 14 Subjective overall ratings for proposed Manchester music studio. 15 consistent observers only

o 12 metres

x 14 metres

Standard error 12 metres

Standard error 14 metres

These results are plotted in Figures 13 and 14 where the trends are more easily seen. The general choice for reverberation time is in the 2.25 to 2.5 seconds region with the consistent observers tending to prefer the higher value. Strictly the individual standard errors do not allow for such discrimination but the similar shapes of the four 'curves' give support to such conclusions.

It is interesting to note that the optimum reverberation time is substantially longer than the long-established conventional value of about 1.9 seconds[7] to which even the extreme of 2.75 seconds is preferred. This result confirms opinions expressed by some operational staff that there is now a growing tendency to prefer more reverberant studios. This tendency does not necessarily apply to concert halls where the ratio of direct to reverberant sound for a member of the audience cannot be modified by microphone placing. As before, the difference of grading for variation of height is too small to be statistically significant.

9 Conclusions

The last set of experiments established a clear preference for the longer reverberation times of 2.25 and 2.5 seconds compared with the 1.9 seconds value. This latter condition had already been described as satisfactory so there should be little doubt about the acoustic quality of a studio conforming to the criteria determined by this work. The recommendations made as a result of these tests are that a studio height of 13.7 metres (45ft) be used together with a reverberation time of 2.25 seconds mid-band.

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New Broadcasting House Manchester: The Building and its Services

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Summary: The article describes the design and construction of the new Broadcasting Centre in Manchester, architectural responsibility for which was undertaken by the BBC's own Architectural and Civil Engineering Department. A project management team was appointed to oversee the work and ensure close control over progress and costs

The complete constructional programme involves three stages, and only the first of these is described in detail here. It comprises a television studio, three radio studios, an Outside Broadcast base, film unit and new studios for BBC Radio Manchester, together with the associated technical areas, workshops and offices

1 Introduction

It was in 1953 that the BBC began to consider proposals for a new television and radio headquarters in Manchester and the first site was purchased in 1956. As the schedule of requirements developed it became apparent that this site was too small to deal with the problems of flexible planning and future developments in broadcasting and it was later sold.

The problem of finding a site which was large enough and sufficiently close to the city centre was ultimately solved by the Manchester City Council, who suggested the present site fronting onto Oxford Road and known as All Saints. In 1967 the Council obtained a compulsory purchase order on all the properties on the site, but the extensive negotiations, valuation of properties and compensation to the former owners were not completed until the end of 1971.

Detailed planning of the new headquarters began in 1967, the BBC employing external architects and other professional consultants as had been the practice for the Television Centre in London and new studio centres at Birmingham*, Cardiff and Glasgow. This culminated in the granting of the outline planning approval by the City Council in December in 1968.

The situation with regard to the facilities required, the cost of the total project and the need to provide a flexible plan which was capable of development in progressive stages caused the abandonment of the detailed planning on the then-current design in February 1970. It was decided that Architectural and Civil Engineering Department of the BBC should take architectural responsibility for a new design, initially on a reduced scale, but capable of development into

*See BBC Engineering Number 87, July 1971.

a total broadcasting centre where all the activities of television and radio in Manchester could be concentrated. This would cater for the Network Production Centre (producing television and radio programmes for the national networks), a Regional television operation, a local radio station and a base for outside broadcasts.

It was decided that the construction should proceed consecutively in three stages:

Stage 1	Network Production Centre, local radio station and outside broadcasts base;
Stage 2	A large music studio for use by the BBC Northern Symphony Orchestra;
Stage 3	The Regional television operation.

Revised outline planning permission was received in March 1971 and the final statutory approvals were obtained in time to allow preliminary work to begin in December of that year with a projected service date for broadcasting of summer 1975.

2 Administration and organisation

2.1 General

A specially-appointed management team was established as a result of the decision that the BBC should assume responsibility for the detailed design work.

A Project Manager was appointed with responsibility for assembling technical and building information, liaising with all specialists, preparing the project plan and financial estimate, and managing and progressing the entire project including the financial aspects. A Project Control Group was established whose members included the Head of Studio Capital Projects Department, the Chief Architect, the Chief Civil Engineer and the Project Manager. These concepts had already been tried in the later stages of the Birmingham and Local Radio developments. Two new ideas were to have a Project Design Group and a management contractor. The project design group was set up under the chairmanship of the Chief Architect and all relevant contributors to the project were invited. The management contractor was appointed to manage the whole building contract.

2.2 Project design group

As its name suggests, the group was responsible for developing the design and overseeing the project to completion. This involved costing the operation, determining the time-table, choosing methods and materials for construction, resolving problems between contributors and evolving an administrative process for the efficient organisation of the project.

The regular members of the group were the Chief Architect (Chairman), Chief Civil Engineer, Project Manager, Principal and Project Architects, management

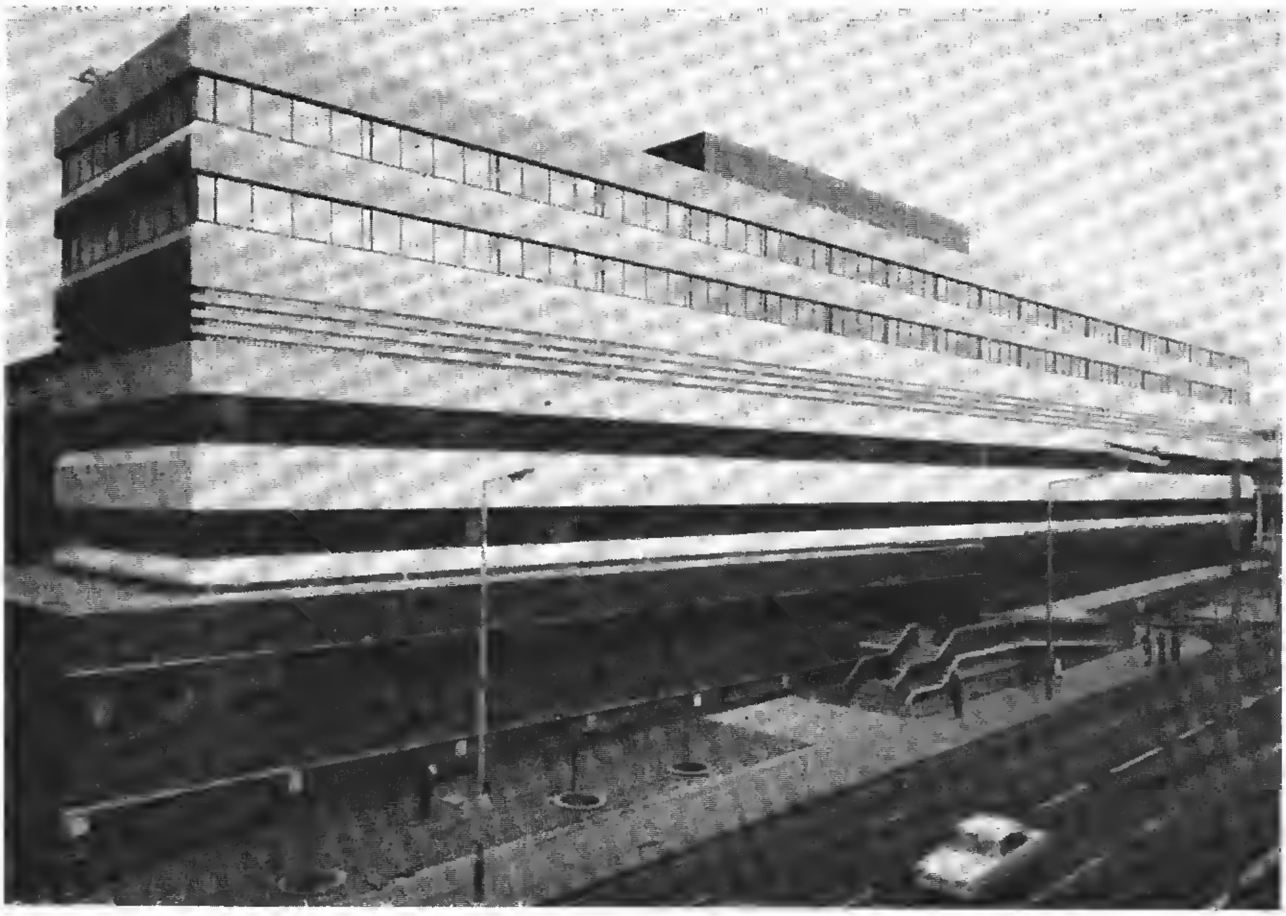


Fig. 1 New Broadcasting House, Manchester

contractor, quantity surveyors, structural engineers, and consultants for the mechanical services, acoustics and the technical aspects of the architecture. An important feature of their own administration was the 'Design Group Memorandum'. These were serially-numbered and could be generated by any member, but copies had to be sent to all other members. No other correspondence between members was permitted. Furthermore, although any member could effectively instruct the management contractor, he could only do so through the Project Architect who would issue a formal 'Instruction Sheet'. This strict control was exercised over the whole job.

Project Architect and Project Manager held separate monthly progress meetings throughout the project, and the whole system of administrative and organisational control worked extremely well.

2.3 Management contractor

The principle of management contracting had been used for some time, usually by firms offering a complete professional, technical and contracting service for a fee related to the cost of the project. In BBC terms the problems were to appoint a contractor with experience in the broadcasting field, to maintain the competitive aspects of normal tendering procedure and to allow sufficient flexibility in the planning and contracting stages to insure against possible failure or poor performance.

The management contractor was responsible for providing all the general preliminaries and conditions of a normal contract, e.g. site organisation and supervision, hoarding, scaffolding, craneage, lighting and watching, water for the works, attendance trade upon trade, insurances, compliance with statutory requirements and testing materials. The building work was divided into suitable units and competitive tenders, based on a separate Bill of Quantities for each part of the work, were invited by the management contractor for each. The tenders were subject to examination and acceptance by the quantity surveyor and the project architect.

The project divided itself reasonably conveniently into approximately forty units covering every aspect of the work from excavation to lightning conductors.

The project was in two phases, the first of which terminated when the building was wind and watertight, and separate tenders were invited for a management contractor for each, although in the event, phase two followed without pause. This was advantageous because a long gap would otherwise have been necessary to allow time for ordering and delivering materials. In addition, subcontractors working on both phases might have revised their estimates and rates, pushing up the total cost.

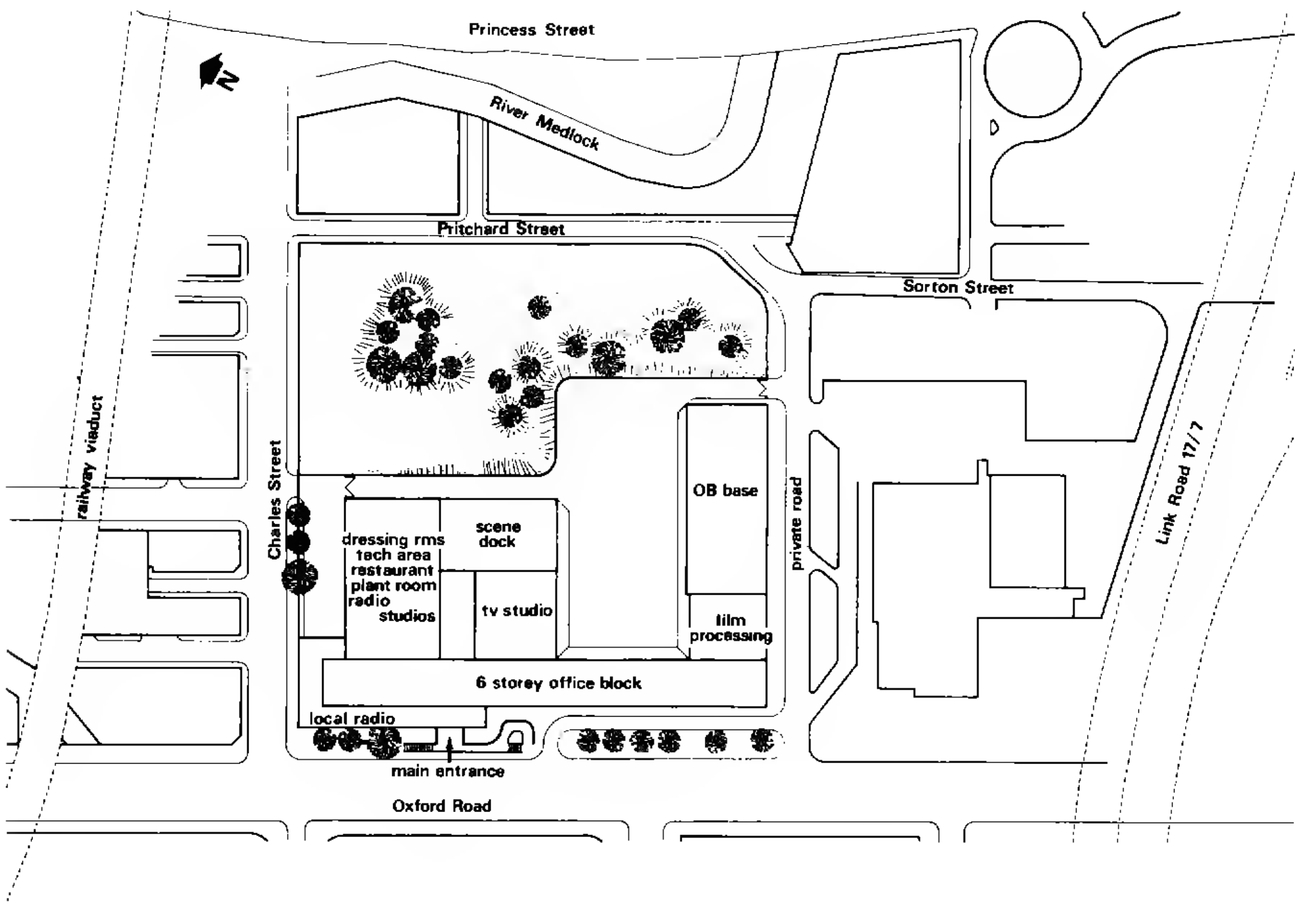


Fig. 2 The site layout

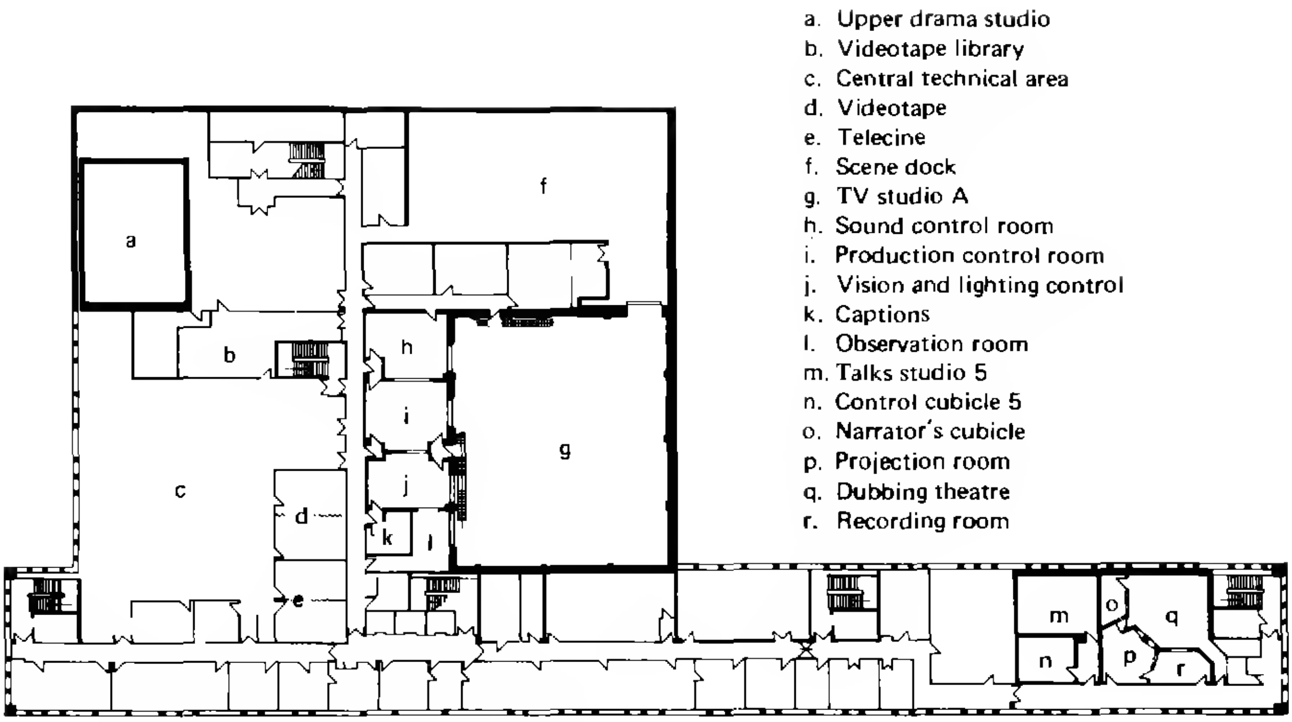


Fig. 3 First-floor plan showing the most significant areas

3 Site

The 1.66 hectare site is situated in Oxford Road near the centre of Manchester, close to the Oxford Road main-line railway station and the University precinct. Its disposition is shown in Figure 2.

The frontage on Oxford Road is about 120 metres and the site falls 2.5 metres from the private road to Charles Street and approximately 4.25 metres diagonally from south to north. Soil investigation indicated no major constructional difficulties which could not be solved by short-bore piling, although the water table in the northern corner of the site (some 4.25 metres below ground) required special attention to the drainage arrangements.

On the site were a number of semi-derelict buildings of various types and ages from back-to-back, two-storey houses of the early 1800s to four-storey warehouses and shops. There were a number of minor roads traversing the area, paved with cobblestones and covered with tar paving. The cobblestones were salvaged and have been re-used on the forecourt of the new development. The old properties were demolished except for a tailor's shop which remained open until well after work began. The presence of this building delayed general building operations as its drains had to be diverted and brought into the new system.

4 Planning

4.1 General

The design considerations included the relevant disposition of each area in relation to others, effective circulation, sound-proofing, structural isolation, acoustic treatment, the provision of under-cover car parking space, and a sufficiently large hardstanding for Outside Broadcast vehicles. The building had to be designed to form a complete and acceptable entity whilst making provision for future development. The main areas called for in the schedule of requirements were a general-purpose television studio with its associated control rooms, a Central Technical Area, make-up, wardrobe and scenery areas; radio drama, talks and news studios, cubicles with recording and dead rooms; an Outside Broadcast base and office, restaurant and BBC Club facilities. The accommodation for Radio Manchester was to be self-contained with its own entrance.

The general layout was fairly quickly apparent: the covered parking should occupy the low end of the site, with access from Charles Street, forming a lower ground floor and avoiding excessive excavation for a basement. Local Radio should be easily accessible with its own entrance and parking, conveniently on the Oxford Road/Charles Street corner. The Outside Broadcast base, where a level hardstanding and traffic-free access were desirable, should be entered from the private road. It followed from the position of the hardstanding that the workshops, scene dock and the television studio should be built around it for ease of circulation, bearing in mind the future development of the television Regional Centre. As the television studio was to be three storeys high, it was reasonable to put its control suite and the associated technical area on the first floor. (See Figure 3).

The main entrance should obviously be from Oxford Road, but off-street parking for visitors was necessary and resulted in the private road parallel to Oxford Road. The radio complex was concentrated in the area adjacent to the television studios with the future proposal for an orchestral studio in mind. Film Unit required access at street level for film and equipment and was, therefore, located at the

southern corner of the complex, linking the six-storey office block with the Outside Broadcast area. (See Figure 4, pages 18/19.)

On the second floor, the restaurant, kitchen, BBC Club, hospitality and conference rooms were conveniently grouped together, thus concentrating most of the plumbing into one area.

The third floor was devoted entirely to heating and ventilation plant and associated workshops, offices and stores. This new concept for broadcasting premises avoided excessive lengths of large-section ducting for the studio and located the plant centrally, though it presented elevational problems and increased the loadings on the building frame.

The major office requirements were concentrated on the fourth and fifth floors, with corridor walls being permanent and doors on a regular grid. The inter-office partitions are fully demountable for maximum flexibility in office planning.

The roof area is designed to accept a further storey of offices and contains the lift motor and tank rooms as well as the air-conditioning cooling towers.

4.2 Lower ground floor

There was much discussion with the statutory authorities about car parking because planning policy is generally to discourage the use of private cars in the city centre and there are multi-storey car parks nearby. Eventually the authorities agreed to the provision of forty-eight spaces for essential vehicles.

The original intention was to provide parking at the rear of the site but this would have inhibited future development. An accurate survey showed that it was possible to provide covered parking space without unnecessarily-expensive basement construction and the authorities readily accepted this solution. The garage area is ventilated by a mechanical extraction system aided by natural ventilation through grilles in external walls and has a sprinkler system. Access to the upper floors is by the main staircase and one of the three passenger lifts.

A goods lift was required to service the technical stores (1st floor), the restaurant and Club (2nd floor) and the plant room (3rd floor), connecting them with a covered loading-bay and waste-storage area at street level.

The electrical substation and main switchroom are at street level to facilitate the installation and possible replacement of very heavy equipment. To allow the specialists maximum time for detailed planning, the area was constructed as a solid slab at the lowest duct level with brickwork ducts built up from it and lightweight concrete filling between them up to floor level. The diesel-alternator and battery rooms are also at this level as it was comparatively simple to install a ventilation plant and a 4,500 litre underground fuel tank. It was also convenient to situate the reverberation-plate room, publications store, lines-intake room and water-meter room on this floor.

Except where regulations or the need to keep dust to a minimum dictated, the lower ground area has been left in its natural building finishes to keep construction and maintenance costs down.

4.3 Radio Manchester

This area was concentrated on the upper ground floor at the western corner of the building with its own entrance and reception area. The entrance is extended to form an open-sided, covered parking area for use exclusively by local radio vehicles.

The ambient noise levels of Oxford Road and Charles Street (more than 90 dBA on the inside edge of the pavement) dictated that the studios should be as far as possible from these sources. The studios were therefore situated 'en suite' as the inner part of the local radio area, insulated by a corridor and the surrounding offices. The corridor, incidentally, saved space because it provided one continuous sound lobby rather than individual ones. To reduce the noise in the offices the windows overlooking the street were double-glazed; this is the only part of the building where this is necessary.

To avoid the possibility of direct sound transmission into the studios and control rooms through the floor from the car park beneath, a double-skin concrete floor was used with the upper layer supported on rubber isolation pads.

The acoustic treatment in the studio areas is appropriate for speech origination, control and monitoring. The noise criterion applicable for critical operational areas was curve 'b' in the current BBC standard for permissable background noise levels in studios*.

It was originally intended that the acoustic treatment for the walls and ceilings should consist of 600 mm square modular absorbers with perforated hardboard fronts. However, during the design stages for a music studio model, an alternative 'in-situ' method of construction was evolved. It proved economical and convenient to use and it permits a variety of hard-wearing finishes to be applied.

The gross area for local radio is 754 square metres.

4.4 Television studio

The general-purpose colour studio, of 453 square metres with an available acting area of 16 x 20 metres and provision for an audience, forms the operational hub of the upper ground floor. The studio has direct access to the Outside Broadcast hardstanding, male and female quick-change areas, studio technical equipment store, audience and artistes entrances and the scenery transit area. Metal staircases from the studio floor give access to the lighting gallery and to the production, vision and lighting control rooms. The integrated design of the reinforced-concrete columns, the air-conditioning trunking, the acoustic treatment and the technical installation have produced an effective studio whose cleanness of line gives it an air of efficiency, further emphasised by the extremely functional and uncluttered lighting grid. The height of the studio to the underside of the lighting grid is 5.47 metres and the designed reverberation time is 0.6r seconds.

As with most studios, it was extremely difficult to find sufficient wall and ceiling area for the acoustic treatment but, by the use of 'in-situ' cladding referred to in section 4.3 and by the provision of a false ceiling and draped quilting between air-conditioning ducts, the desired reverberation time has been achieved.

*BBC Guide to Acoustic Practice

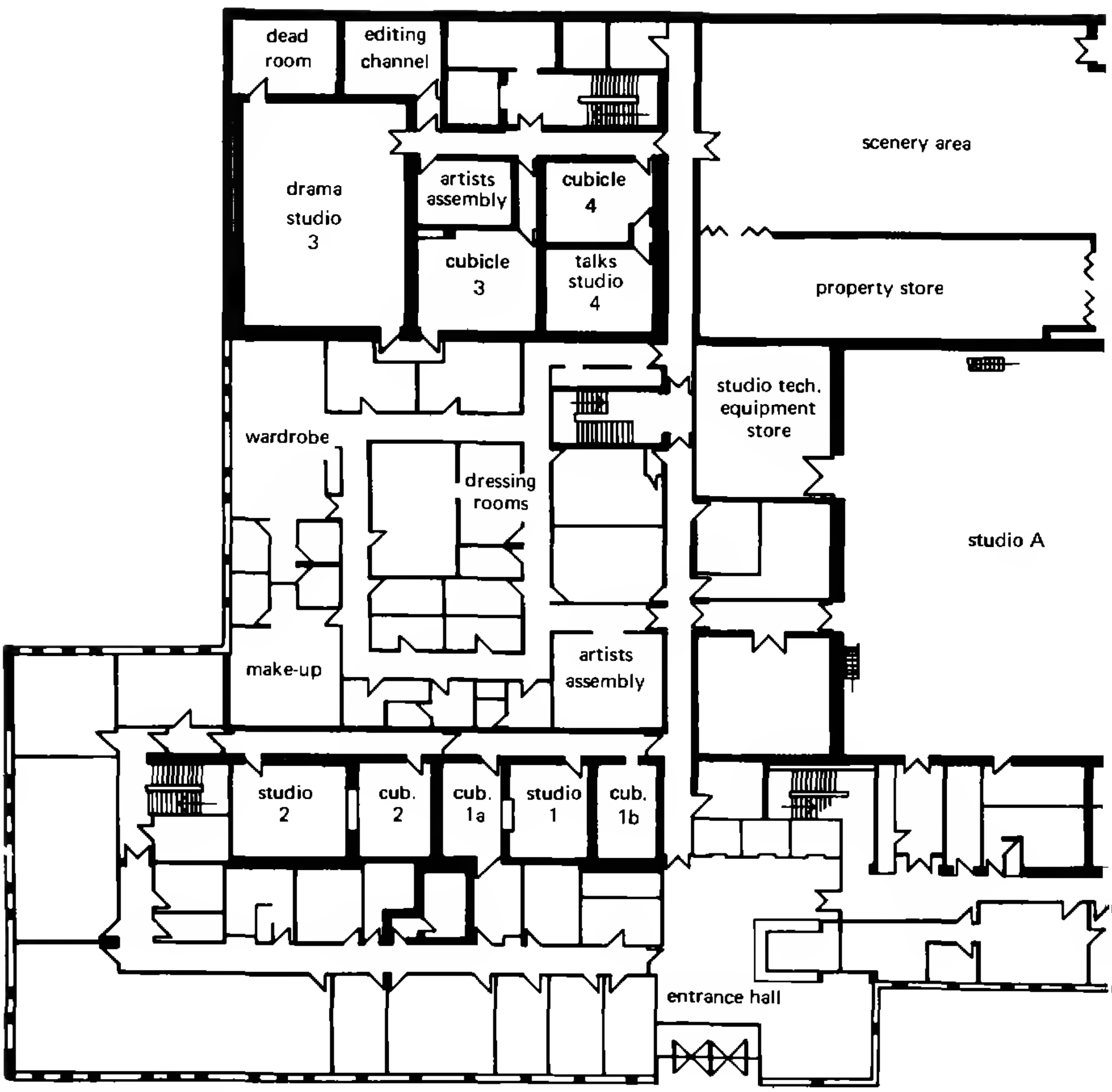
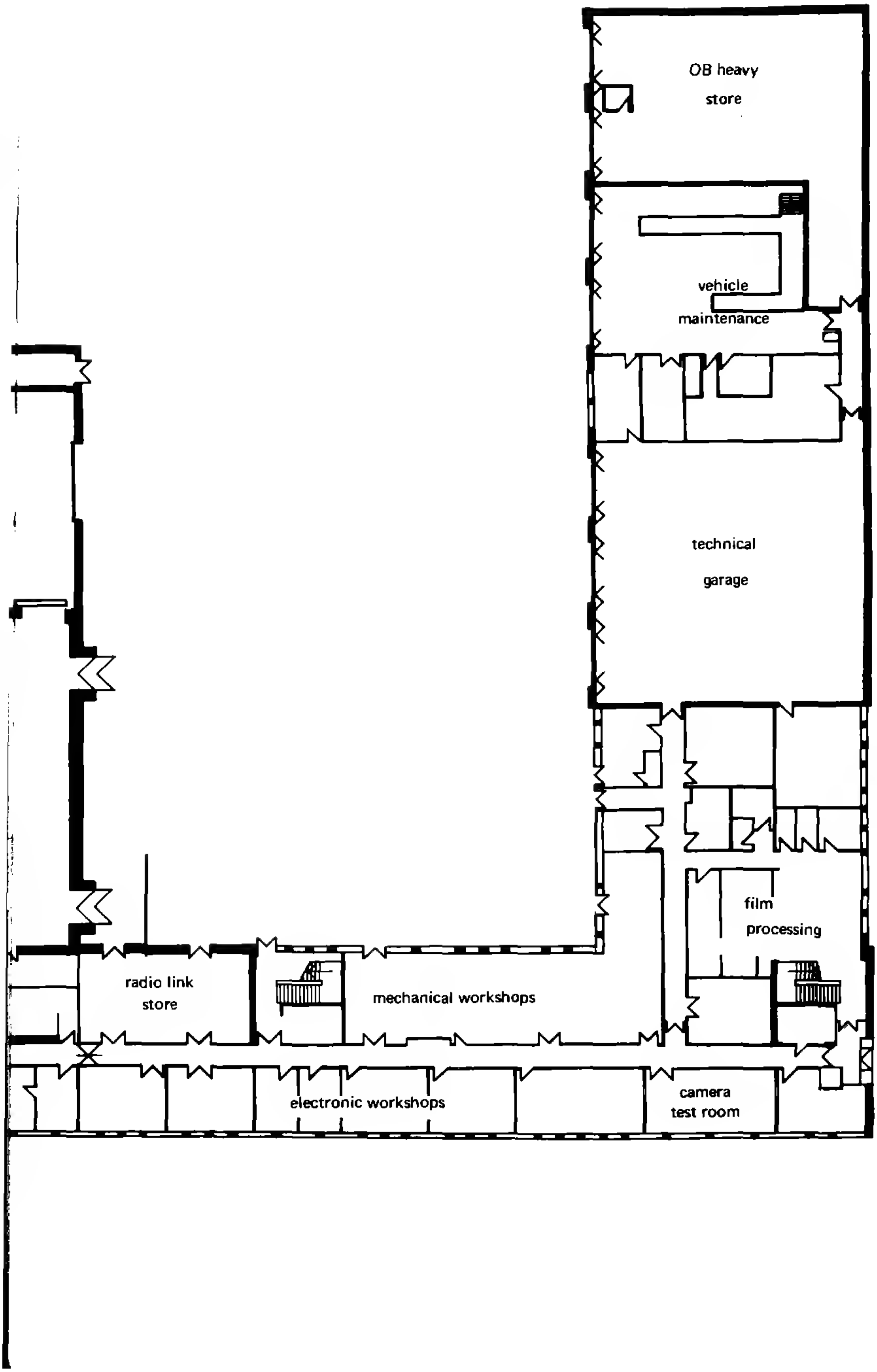


Fig. 4 Plan of upper-ground floor


OB heavy store
vehicle maintenance
technical garage
film processing
radio link store
mechanical workshops
electronic workshops
camera test room

Windows in the control rooms, although restricted to 2.4 x 1.2 metres maximum in order to standardise the glazing and reduce costs, were still big enough for the control desks to be lifted into position from the studio.

Acoustically-isolating doors to the scene dock and hardstanding were a problem. A slide-and-clamp door to the scene dock provides 47 dB average insulation over the range 100 Hz - 3150 Hz.

The specially-designed double doors, for audience escape to the hardstanding, have a total insulation of 58 dB.

4.5 Scenery workshop and stores

These areas conveniently adjoin the television studio and access for scenery, stores and equipment is from the hardstanding. Basically the scenery area is a single-storey building 7.35 metres high to the underside of the steel trusses. This height permitted the construction of a second storey over part of the area containing offices and a locker room. Access is by a circular iron staircase.

The area is naturally lit by four flat roof lights, each of which is 7.20 x 2.03 metres, supplemented by three smaller roof lights approximately 1.2 metres square.

The total gross area of this section is 572 square metres.

4.6 Artistes' facilities

Eleven dressing-rooms (accommodating various numbers of artistes), two fitting-rooms, wardrobe area with laundry, make-up rooms, artistes' green room and assembly areas have all been situated close together at ground level as close to the television studio as possible.

4.7 Workshops and test rooms

These areas form the main part of the frontage to Oxford Road at upper ground floor level but, because of the falls of the site, are at the same level as the Outside Broadcast hardstanding and the television studio. By providing access through double doors from the principal working areas to the hardstanding and a covered way along the whole of the rear of this part, it is possible to move equipment from the television studio directly into the appropriate workshop.

Experience has shown that areas of this nature are inevitably subjected to heavy usage and damage to walls. The heavy-duty workshops have, therefore, been treated as factory areas with no plasterwork or masking of suspended ceilings; their walls have simply been painted but the electronic workshops have been plastered. All the workshops have been fitted with purpose-made benches and, despite the lower standard of wall finishes, provide a very pleasant working environment.

The total area of the workshops and test rooms is 600 square metres.

4.8 Film processing areas and dubbing theatre

The southern corner of the site was the most convenient location for the Film Unit. There is access for film and equipment, the processing area (linking the Outside Broadcast base with the main block) was easily provided with acid-resistant drainage and the false floor at first floor level is convenient for the review and dubbing theatre. The cutting room and offices are on the second floor and a film hoist links the various floors. The processing area has epoxy-resin pavings and is finished with acid-resisting paint. The area stands on a void tanked with acid-resisting asphalt.

The dubbing theatre is built on the basic floor slab and the projection room, narrator's cubicle and recording room are on the false floor so that a clear view of the screen is obtained. The whole area is air-conditioned and acoustically treated for a reverberation time of 0.3 seconds. The noise criterion is curve 'b'

The film cutting, sync, dispatch and storage rooms and the film library are on the second floor. They are air-conditioned or have cooled ventilation and background noise level is approximately NR 40 for those areas on the Oxford Street frontage.

4.9 Outside broadcast base

This single-storey building has seven bays which can accommodate vehicles up to 10.7 metres long and 4.6 metres high. An eighth bay is divided into a transport office, battery-charging room, toilets and showers. Natural lighting is by eight ventilated rooflights.

There are two inspection pits in the garage and outside is a concrete apron on which vehicles are washed. The drainage system has a petrol interceptor.

4.10 Radio studios

The four basic considerations in siting the radio studios were access, noise, the height of the drama studio and the possibility of expansion. The Charles Street wing was appropriate for expansion and the wide forecourt helped to solve the noise problem although structural isolation from the garage was necessary.

The major element is the drama studio (Studio 3) and its associated dead room, control cubicle, recording channel and combined narrator's studio and green room. The studio has dimensions of 13.71 metres x 8.53 metres x 4.26 metres high. It is divided by a double curtain and has retractable carpet in one half so that the two halves can have different acoustic properties. The reverberation times for the studio are shown in Figure 5.

The dead room has its ceiling and one wall lined with flame-retardant, glass fibre anechoic wedges supported by wire mesh. (See Figure 6.)

The control cubicle and recording channel have suspended cavity floors and the noise criterion is curve 'c'.

The whole of the studio is air-conditioned and has a total area of 321 square metres.

4.11 Central technical area

In this are concentrated all the apparatus for the television studio, communications and programme distribution, together with the telecine and videotape equipment. The advance maintenance and film handling areas, videotape library and technical equipment stores are also included.

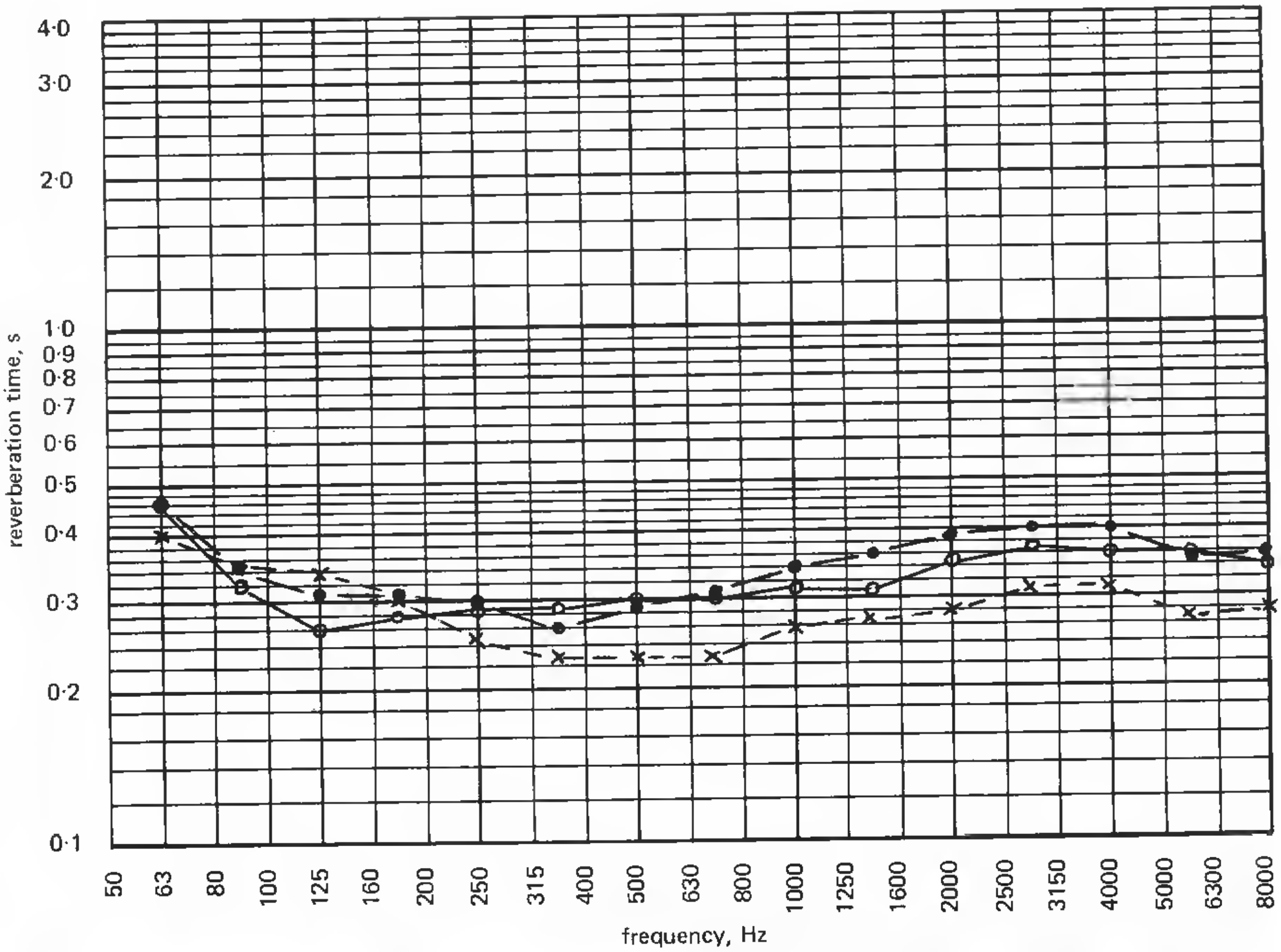


Fig. 5 Reverberation times for studio 3 o——o Full studio x----x Dead end •——• Live end

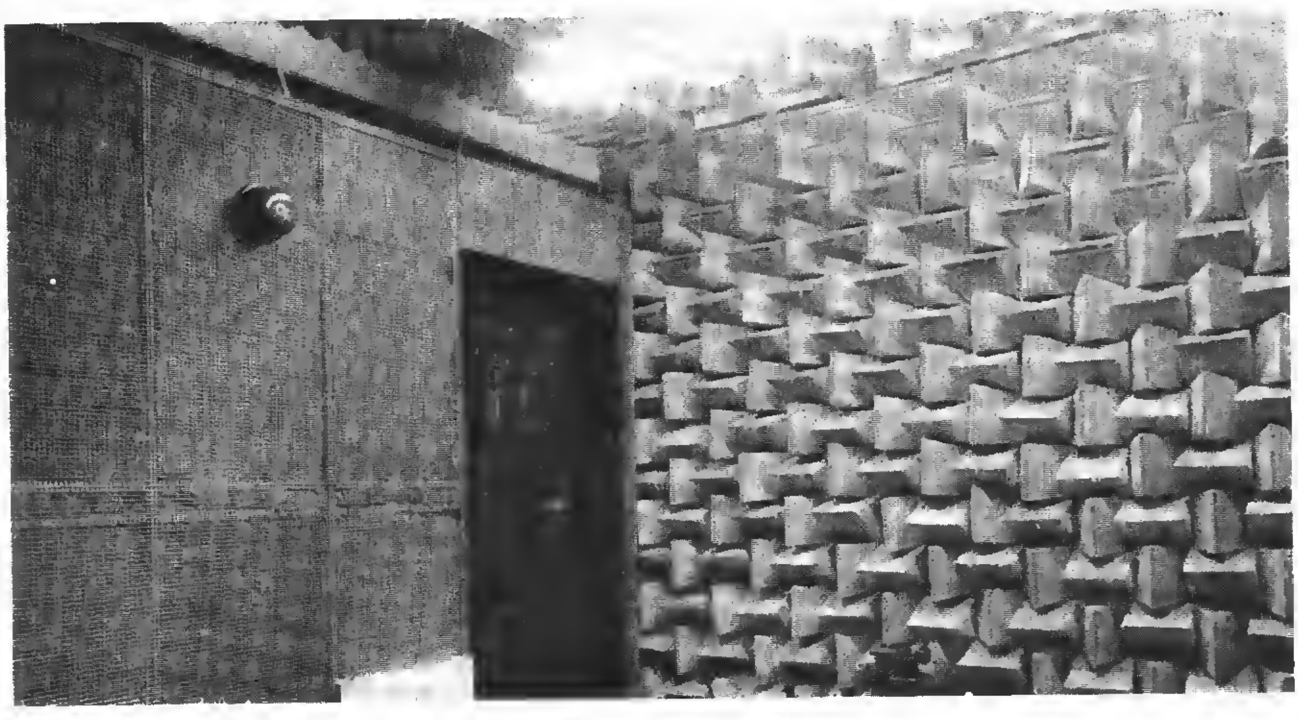


Fig. 6 Acoustic treatment of the dead room adjacent to studio 3

The central technical area is on the first floor which is most convenient for personal and technical access to the television studio control suite. Because a suspended, cavity floor has been provided, cabling to other areas has been relatively easy. The total area is 935 square metres.

4.12 Control suite

This consists of production, sound, and vision and lighting control rooms, supplemented by captions and observation rooms and, as is usual, is at first floor level. Sound lobbies are provided from the main corridor to each area and from the control suite to the studio. There are observation windows from each area into the studio and between areas. The suite is air-conditioned to match the studio and the background noise criterion is curve 'b'.

The reverberation time of the production and vision-and-lighting control rooms is 0.2 to 0.34 seconds at middle and upper frequencies and the sound control room has a reverberation time of 0.3 to 0.35 seconds.

The total area of the suite is 206 square metres.

4.13 Restaurant and kitchen

These are on the second floor overlooking Charles Street. There is easy access for staff and visitors, and good natural lighting, kitchen odours are away from other working areas, services and waste disposal are convenient and it is near hospitality areas, conference rooms and the BBC Club.

The restaurant has been designed to cater for the whole Manchester headquarters when it is completed, and can seat 180 people. The servery is U-shaped for the convenience of customers.

4.14 BBC Club facilities

The Club area has been placed on the south side of the main axial corridor opposite the restaurant and kitchen so that it can make use of the goods lift and the access to the flat roofs as a sitting-out area. It has been provided with its own entrance vestibule with telephone and toilet facilities.

The amenities are not as extensive in the first stage as might be desired. It is to be hoped that in the development of future stages, provision can be made for table tennis and billiards, a quiet room and other recreational facilities.

A flat-roof area, accessible from both the restaurant and the Club, is laid with octagonal paving and has similarly-shaped flower containers. The view from this roof is not comparable with those from other BBC premises as it is restricted to a panoramic view of a miscellany of buildings and the elevated Mancunian Way; nevertheless, there is an almost enclosed area of 560 square metres.

The gross area of the Club accommodation is 164 square metres.

4.15 Air-conditioning and heating plant areas, tank rooms

The decision to concentrate the major items of heating and air-conditioning plant, including boilers, water pumps, refrigeration machines and air-handling units, on the third floor, limited the problem of rising ducts throughout the building. Maximum use was made of the available floor space to effect the main horizontal distribution of the required air volumes within the plant room and then to connect to a total of five vertical shafts located at regular intervals along the building, adjacent to the staircases. The principle enabled false ceiling space for the secondary distribution ducts at the various levels to be kept to a minimum.

The third floor was also ideally situated for direct high-level entry to the television studio and the large-section, low-velocity ducting associated with the studio was restricted to relatively short runs.

The mechanical engineering workshops and stores are located on the third floor to facilitate maintenance. In the event of major equipment replacement, access can be made in both the roof and rear face of the building. The control room, which houses the automatic control panel, is adjacent to the workshop and provides continuous monitoring of plant status throughout the building.

It was neither practicable nor desirable to place some of the small specialist extract-air plants (for the car park, toilets, sub-station and film processing, for example) in the main plant room and these are situated either in the vertical shafts or on the roof adjacent to the areas they serve. Similarly, the water-cooling towers for the refrigeration plant are located next to the main water storage tanks at the fifth floor roof level.

5 Building construction

5.1 Drainage

There are separate foul and surface water drainage systems. Because of the depth of the main sewer connections and the main services under the road, headers had to be constructed by mineworking specialists. The total capacity of the drainage system is 54,500 litres which is equivalent to 32 mm of water over the total area of the site.

5.2 Foundations

The building is supported on piles in loadbearing sandstone, the deepest being 13.38 metres. There were 214 bored piles from 600 to 1500 mm diameter with a total concrete content of 1650 cubic metres — approximately one sixth of the total of the concrete frame for the building.

5.3 Reinforced-concrete frame

The building frame is generally of reinforced concrete with flat soffit slabs. This type of construction was found to be the most economical and also offered uninterrupted soffits for fixing ducting and the technical cabling runs, utilising the building space to the full.

One disadvantage, however, was that with the very high proportion of steel reinforcement (particularly at the perimeters) it was difficult to find sufficient space for the external cladding fixings. The average reinforcement content of the whole of the reinforced-concrete structure was about one tonne per ten cubic metres of concrete.

5.4 Structural steelwork

The television studio roof is supported by four, 4.4 metre-deep steel trusses, each spanning 23 metres and weighing approximately four tonnes. These trusses also support the lighting grid and the scenery and lighting and hoists.

The scene dock and Outside Broadcast garage are steel-framed and the structural steelwork weighed 135 tonnes. It is protected by five coats of paint.

5.5 External cladding

The six-storey block is clad in precast concrete panels. There are nearly five hundred panels of eight main designs. Other exterior cladding is of red facing brickwork. Altogether over a million bricks and seventy-two thousand lightweight concrete blocks were used in the building.

All windows are in purpose-made aluminium frames with bronze-tinted solar-heat-rejecting glass. Their total area is 2100 square metres.

5.6 Radio studios

Studios and their cubicles have been constructed as floating boxes with floors of precast concrete beams floating on studded rubber pads on the structural floor. Reinforced-concrete beams were finished with structural topping and supported the enclosing 113 mm brick walls. A minimum cavity of 50 mm separates each cubicle and studio from the next.

The ceiling of each 'box' was formed with joists supporting pre-screeded, channel-reinforced, woodwool slabs for extra density, giving a total thickness, including screed, of 87.5 mm. The lattice girders were spaced so that 600 mm-square boxes could be fixed between them, and joists and boxes together were left exposed to form a ceiling. This eliminated the expense of an additional false ceiling.

5.7 Television studio

Acoustic insulation was provided automatically as the height of the structure demanded a minimum of 225 mm brickwork and therefore the studio is enclosed by two skins of 225 mm brickwork with a minimum of 50 mm cavity. Both skins are supported on a single ring beam foundation.

Because of the height and spans of brickwork, it was necessary to build-in both vertical and horizontal expansion joints. The floor is reinforced concrete on hardcore and solid ground and is capable of taking the maximum loads envisaged for studio use. The floor surface is of 6 mm linoleum on 25 mm paving on 25 mm cement-and-sand screed, laid to a tolerance of ± 2.00 mm over a distance of three metres.

The double-skin roof consists of a reinforced-concrete slab, 150 mm thick, which supports tapered, reinforced-concrete beams at 3160 mm centres; these stand on rubber pads. The beams in turn support the lightweight second skin consisting of 75 mm-thick, channel-reinforced, woodwool slabs, screeded with 40 mm lightweight concrete. The roof was made watertight with 20 mm asphalt and white chippings. The whole of the roof was supported on four mild-steel lattice girders, increased in depth to enable the grid to be hung from the bottom beam and to allow access through the struts and hangers for air-conditioning ducts and maintenance.

5.8 Dubbing suite

The area is isolated from the rest of the building by 275 mm cavity brick walls. Internally, the narrator's cubicle and the recording room have been floated as independent 'boxes' similar to those in the sound studio suite. In this case, however, to allow for future development, the walls of the 'boxes' were constructed of softwood studding on the same principle as that used in the old Camden Theatre and referred to ever since in the BBC as 'Camden' partitioning.

The review theatre has no suspended floor so that there is sufficient floor-to-ceiling height for the projection screen.

6. Fire precautions

The building has been compartmented horizontally to prevent the spread of fire from one floor to another and six fireproof staircases have been provided. The main staircase, surrounding the three passenger lifts, has a pressurised lobby to ensure smoke-free access to all floors for fire-fighting. Wet and dry risers, hose reels and hand appliances have been installed throughout the building, and there are fire dampers in the air-conditioning ducts.

Automatic sprinkler systems have been fitted in the lower ground, scene dock, dressing-room and wardrobe areas, but in the studio and technical areas, where sprinklers cannot be used, there are smoke detectors. All of the automatic systems are monitored in the fire duty room and alarms are automatically passed on to the local fire station.

7 Air-conditioning and heating installation

7.1 General

The decision taken during the early planning stages to provide fixed glazing throughout the offices to combat traffic noise and consequently to air-condition these areas, prompted an examination of the heat-recovery concept.

Broadcasting premises normally contain a large number of heavily-insulated areas, with substantial heat dissipations from lighting and technical equipment which requires cooling throughout the year. This is normally achieved by mechanical cooling during warm weather and by utilising outside air when external temperatures are below about 10°C. In each case the heat removed is dissipated to atmosphere.

Fuel costs at the time the decision was taken (1970) indicated that electrically-driven refrigeration system (Figure 7) operating throughout the year and circulating warm water (43.5°C) from a double bundle condenser, could offer small savings in heating costs and, providing no increases in capital costs were involved, showed promise for the future. Subsequent increases in fuel costs have roughly doubled the savings.

Two open-type screw machines were selected and one was

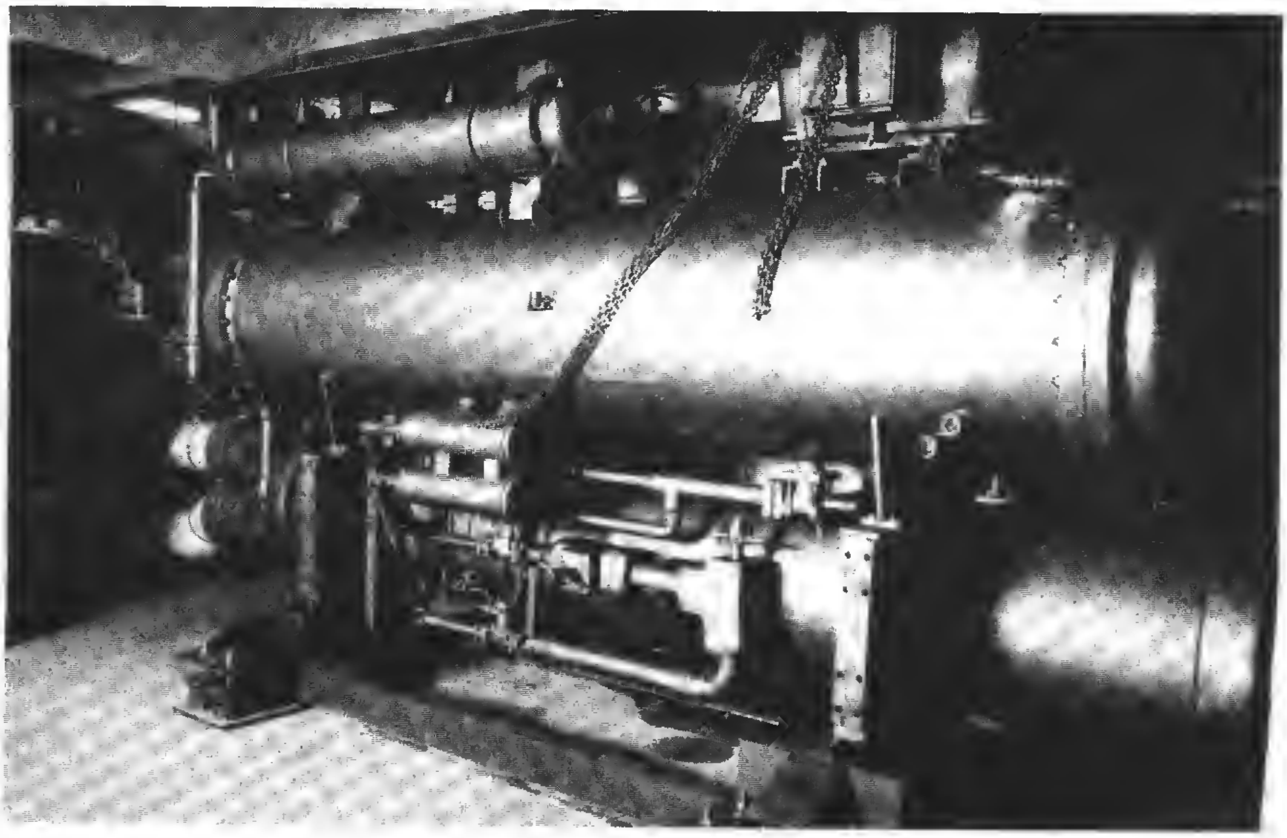


Fig. 7 One of the refrigeration units in the plant room.

arranged for heat recovery, the other as a standard water-chiller. Their outputs are, respectively, 985 kW and 1195 kW when chilling water from 10.8°C to 5.6°C. These capacities allow for future development and it is unlikely that both will be required to operate at this stage.

The warm water from the heat-recovery condenser is pumped to the office induction units, air-heater batteries in all the air-handling plants, unit heaters serving the inner part of the Outside Broadcast base and sundry fan coil heaters in workshop and similar areas. The facility is also provided to pre-heat the domestic hot water whenever the recovered heat cannot be fully utilised for space heating.

Twin medium-pressure hot-water boilers, each rated at 1750 kW and fired by natural gas, are provided to heat the building during very cold weather when the heat recovered is insufficient to meet requirements. This load increases progressively as the temperature falls below 9°C. The system is pressurised automatically and the distribution circuit contains one primary pumping set.

7.2 Offices

A four-pipe, twin-coil, damper-controlled induction-unit system was selected for the office air-conditioning with a unit under every window module; it was considered that with hot water at a suitable temperature from the heat-recovery plant, this system offered maximum flexibility for differing space temperature requirements and future re-positioning of partitions.

The individual pneumatic operators give a range of approximately 18.3 to 24°C, dependant on the external conditions, the selected temperature being held to within 1°C.

7.3 Conference and refreshment areas

A fresh-air system serves the restaurant, Club, hospitality and conference room areas and incorporates various terminal box arrangements including single-duct, constant-volume and variable-volume re-heat. All air-heater batteries both at the main plant and at the terminal boxes are fed with water from the heat-recovery circuit.

Extract is through a polished aluminium canopy fitted with grease filters and located over the central island cooking site. Extracted air is also taken through connection to the inlet and outlet of the dish-washing machine. An axial-flow fan unit discharges this air at roof level.

The system is designed to maintain the temperature in all areas, except the kitchen, of 21° ± 1°C with the relative humidity normally in the range 40-60%, but falling to 30% in colder weather.

7.4 Television studio

The television studio is served by a conventional low-pressure, low-velocity system, the air-handling unit fan providing both supply and return air. A small diameter axial-flow fan is employed to exhaust a quantity of air equal to the fixed fresh air volume in order to keep the studio in balance at all times. This is important if air noise at doors is to be avoided.

The supply air is discharged through four open ducts

which terminate above the lighting grid and allow the air to flood out into the studio. These outlets are positioned to quarter the studio effectively, and each zone branch is fitted with a re-heater battery served by water from the heat-recovery circuit.

The system is designed to maintain a temperature of 21 ± 2°C, and relative humidity (although not controlled) will normally be in the range 40-60%. The noise level meets BBC noise curve 'b'.

7.5 Technical areas

A single, variable-volume plant was chosen to serve all those areas which could be loosely-termed 'technical'. The layout of the building conveniently grouped these into ten zones, typical examples being local radio, dressing-rooms and television control rooms. Air-conditioning in any of these zones can be switched off from the main control room either manually or by timeswitch.

In order to achieve maximum power savings, twin, variable-pitch axial-flow fans were installed for both supply and extract purposes. In addition to a substantial acoustic enclosure for the plant, extensive use of in-duct silencers was made to ensure no sound carry-over to noise-critical areas. The drama studio and dead room, with a requirement to meet BBC noise curve 'c', are served by this plant.

The system has been designed to hold average space temperatures of 21 ± 1°C. Humidity control is not required for the majority of areas served by this plant but there are a few important exceptions (for example the videotape and film areas) where a relative humidity of 50 ± 5% is required. This is achieved by injecting steam directly into the ducting; the steam is raised in electrically-operated, renewable cylinders which are switched in progressively according to demand.

8 Lift installation

The lift installation, designed and specified by the BBC, comprises five lifts.

In the main reception area at upper ground level, there are three passenger lifts arranged as a triplex collective installation. One of these serves the lower ground floor car park and the third floor plant room as well as the upper ground, first, second, third and fourth floors, which are also served by the other two. Each lift has a capacity of thirteen persons or 975 kg and a speed of 1.5 metres per second.

At the rear of the main block is a 2000 kg capacity, passenger/goods lift serving the lower ground to third floors. It travels at 0.75 metres per second.

There is also a small lift in the film unit area, serving the upper ground, first and second floors. The car has a carrying capacity of 300 kg and a speed of 0.23 metres per second. It is not for passengers but for the transporting of technical equipment and film cans.

9 External works

Section 4 (Planning) will have indicated some of the problems associated with stage-by-stage development of the site. Essentially, the City Planning Department insisted that each stage of the development must be complete within itself and that landscaping should form a part of each stage. Tree planting and grassed areas to improve the total environment were a condition of town planning consent. To meet this requirement, the whole of the rear of the site has been grassed and a number of silver birch trees have been planted. On the Oxford Road frontage the hard landscaping was carried out in cobblestones from the original roads on the site, and six maple trees have been used to provide a screen.

The problems of site security dictated the treatment of brick walling, slate capping and wrought-iron railing to the Charles Street frontage but it has been possible to provide three silver maple trees and one Japanese cherry.

10 Site progress

The management contractor began work on the site in December 1971 and the whole of Stage I, including technical installation, was programmed for completion by the summer of 1975.

The basis of the programming was the two-phase operation which has already been explained, Phase I to be completed by Autumn 1973. Phase II was planned to overlap Phase I by about six months.

The staff moved into the new building during the weekend of 12-13 July 1975, and the new headquarters was brought into operation in September 1975.

11 Cost analysis

The costs of the various divisions of the building were:

		£/m²
1	Preliminaries	18.54
2	External Works and Drainage	8.43
3	Substructure	7.97
4	Structural Frame, Floors and Roofs	24.91
5	Roof Coverings and Lights	3.30
6	External Walls, Claddings, Windows and Doors	16.80
7	Internal Walls, Partitions and Doors	11.59
8	Finishings, Acoustic Treatment and Demountable Floors	18.31
9	Fittings, Lighting Grid, etc.	5.63
10*	Plumbing, Drainage, Hot and Cold Water, Heating and Air-conditioning	53.78
11*	Lift Installation	3.23
12*	Window Cleaning	0.43
13*	Catering Equipment	2.16
14	Attendance on C.P. Departments	3.23
	Sub-Total	178.31
15	Sub-Station/Diesel Alternator/Fire Detection Batteries	5.40
16**	Building Electrical Wiring	9.45
17	Professional Fees and Drawing Office Services	20.61
18	Engineering Specialist Department Effort associated with 1 to 16	9.20
	GRAND TOTAL	£222.97

* Includes associated Builders' Work

** Excludes technical wiring

The final cost reflects the fact that much of the work was done in 1971/72 when costs were much lower than they are now.

12 Conclusions

Tbe BBC now has a broadcasting centre in Manchester as functional and modern as any in the world — it incorporates a number of important architectural and structural concepts which have been combined to provide an efficient centre at a remarkably low cost. It will be greatly enhanced by the future addition of the music stndio for the Northern Symphony Orchestra and the facilities for the Regional Television Centre.

13 Contractors and consultants

Architectural

Designed by Architectural and Civil Engineering Department, BBC

Chief Architect	R.A. Sparks, ARIBA, FRSA
Principal Architect	G.C. Bickmore, ARIBA
Project Architect	O. Young, ARIBA
Job Architect	G. Wilkinson (Deceased)
Job Architect	W. Miller, Dip.Arch.(Man), ARIBA

Mechanical Services Engineering

Designed by Building Design Partnership (Partner-in-Charge, John R. Ellis, C.Eng., MIMech.E., MIHVE) in association with

Chief Civil Engineer	D.G. Nimmy, BSc (Eng.), CEng., MICE
Project Engineer	L.A. Pilch, MASHRAE
Contractor	Haden Young Limited

Electrical Services Engineering

Designed by Studio Capital Projects Department, BBC

Quantity Surveyors	Messrs. Bare, Leaning and Bare
Structural Engineers	Messrs. Ove Arup
Acousticians	Sandy Brown Associates
Management Contractor	Higgs and Hill (Northern) Limited
Electrical Contractor	B. French Limited

New Broadcasting House Manchester: The Technical Facilities

J.M. Elliot, Project Manager, Manchester

Studio Capital Projects Department

Summary: Described here are the engineering facilities in New Broadcasting House, Manchester, the design and construction of which are described in the preceding article. There are new television and radio studios and a self-contained local radio installation for BBC Radio Manchester.

An important feature is the Central Technical Area in which is concentrated much of the technical equipment.

The technical accommodation and facilities provided in the Manchester new headquarters under Stage I replace those located previously in a number of premises scattered around Manchester, including converted churches, factories and part of the old Broadcasting House; the new headquarters is known as New Broadcasting House. All operations other than Regional Television, the BBC Northern Symphony Orchestra and Radio Light Entertainment find their new homes within the Stage I development.

Stage II will include the large music studio, the design of which is described in the article beginning page 5. Stage III will bring Regional Television to the new headquarters.

Stage I includes three network radio studios, one network television studio, a local radio station, television film accommodation, a central technical area, an outside broadcast base, supporting workshops and test rooms and the main substation area with associated battery rooms and standby diesel alternator.

Manchester is a very busy centre on various radio and television networks and the central technical area therefore assumes great importance in the communications field. The CTA is also of especial interest as it is the first in the BBC which has been planned to embrace so many technical functions within the same area. Communications has already been mentioned, and to this can be added telecine, videotape, television studio technical apparatus (vision, sound, communications and production lighting control), a quality check and monitoring room and an advance maintenance area.

Also adjacent to the the CTA are the videotape and technical components stores and just across the corridor is the television studio production suite. All technical functions are therefore closely related physically which will assist the efficient running and staffing of the overall area.

1 Television facilities

1.1 Television — Studio A

This network general-purpose studio (see Fig. 1), which is 418 metres^2 in area, will originate a wide range of productions including current affairs, light entertainment and drama.

Adjacent to the studio are the technical equipment store and quick-change rooms. A special slide-and-clamp sound-insulating door leads from the studio to the scene dock, the production management store, the properties store and the scenic workshop. There is a separate route for artistes from the dressing-rooms, make-up and wardrobe areas, with a further special entrance near the main reception area for audience access.

The cameras used in Studio A are of the EMI 2005 type, with Rank Taylor Hobson Varotal 30 zoom lenses. The studio camera complement is four operational channels with an installed spare channel. A further camera, with zoom lens, is provided as a maintenance spare. The 10:1 zoom lenses give a horizontal viewing angle variable between 5.6° and 56°.

Distribution boxes in the studio have the usual range of facilities for plugging microphone circuits, both single and multi-way, all wired in quad cable. The studio boxes also give access to cue lights, foldback and loudspeaker talkback outputs, talkback and tie lines back to the sound control room.

There are 69 lighting winches in the studio, together with an under-gallery lighting track. Dual-source, dual-wattage luminaries have been provided as the main lighting sources and each winch has two of them mounted on pantographs. The electrically-operated winches are controlled from a console on the studio floor. Certain lighting winches have arrangements for suspending and feeding picture monitors,

Fig. 1 Television Studio A during setting for 'We British', the first television programme from New Broadcasting House

Fig. 2 The uncluttered lighting grid with lighting hoists on the floor and scenery hoists along the wall. Top right is one of the four air supply ducts for the studio

loudspeakers and microphones. These facilities are particularly useful for shows with audiences.

Scenery suspension is by 36 electrically-operated winches which are also controlled from a console on the studio floor and heavy loads can be supported from special steelwork above the studio grid. A twin cyclorama track has been installed. Figure 2 is a view of some of the lighting and scenery winches above the lighting grid.

The production control suite is subdivided into the standard three control rooms for a network television studio. The production control room is situated in the middle, with a back viewing layout, as is the case in the lighting and vision control room. The sound control room layout is arranged to give the sound supervisor a direct view into the studio, but a clear view is also maintained into the production control room. Figure 3 shows the three control rooms.

Standard vision control and lighting control facilities are provided on a single desk and the display of colour and monochrome monitors is shared by the vision and lighting control staff. The right-hand section of the desk contains the lighting control panels, the Thorn 'Q-File' lighting control system occupying most of the layout; it has 250 thyristor dimmers (mainly 5 kW, but some 10 kW), and is controlled through 100 memories with standard preset and output stores. The left-hand section of the desk offers the usual vision control functions.

The vision mixer is of standard BBC design, type EP5/512, similar to those installed in Television Centre Studios 1, 3 and 5. The mixer accepts eight inputs which are paralleled on to two banks and cutting and fading is possible on each channel. Ancillary facilities include colour separation overlay and a wide range of wipe patterns.

A Cintel Mk VIIIB scanner provides caption facilities. This is a standard machine except for BBC-designed remote slide-changing logic and TARIF equipment. It can be controlled locally or remotely from the production control desk. Up to sixty standard 35 mm slides can be used which may be selected sequentially or in a partially random manner.

Sound control is by a new 36-channel Neve desk, with group routing by any combination to eight groups or eight ancillary outputs. The ancillary facilities include pre-hear, public address, echo, foldback and full frequency correction. Limiters and effects units are also incorporated. The two loudspeaker monitoring chains are equipped with LS5/5 loudspeakers and provide a fully comprehensive means of checking any of the inputs or outputs on the desk.

1.2 Telecine and videotape

A Rank Cintel flying-spot 16 mm colour telecine machine is provided in a cubicle in the central technical area. The machine incorporates standard facilities such as TARIF and electronic masking, and will handle comopt and commag sound. Remote control of start, stop and reverse running are also provided from Studio A.

Another cubicle contains two Rank Cintel 9000 slant-track colour videotape machines (Figure 4). These have been fitted with prototype BBC Designs Department Edimase equipment, providing electronic editing capability.

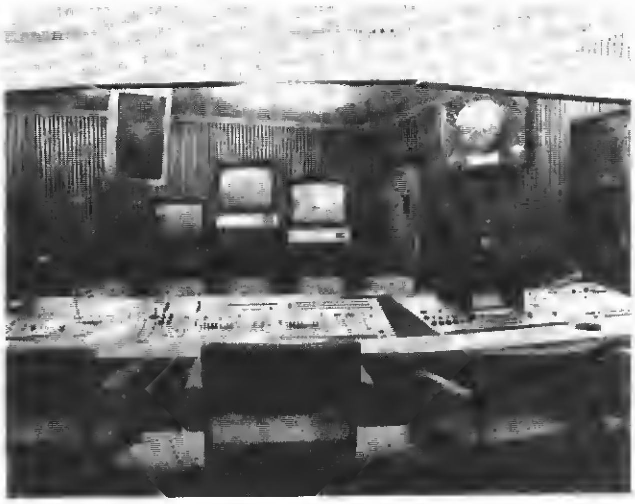


Fig. 3 Television studio production control suite showing (top to bottom) the Production Control Room, the Vision and Lighting Control Room and the Sound Control Room

Fig. 4 Slant-track colour videotape machines

Fig. 5 The Film Dubbing Suite theatre from the narrator's cubicle

The outside broadcast base will accommodate two mobile colour videotape machines which can be used for independent editing sessions at their parking positions, or for insert, recording and replay work by linking them to the CTA and Studio A.

1.3 Film Unit

The Film Unit accommodation within Stage I includes a dubbing suite and editing and sync rooms for network television output. A film processing area has been built, but it will not be equipped until Stage III is completed (the Regional Television development).

The dubbing suite consists of a mixer studio, recording room, optical projection room and narrator's cubicle. Optical dubbing is employed, utilising two 16 mm projectors. One is a double-band, single-speed, reversing Siemens Bauer, and the other a GTC polygon.

The projection screen is arranged so that an effective view is obtained from the recording room and from the narrator's cubicle. (Figure 5). The dubbing desk is a Neve BCM/10 with ten channels, selectable into two groups. Other associated equipment within the dubbing suite include Perfections Sepmag equipment and gramophone, tape and cartridge machines. The studio and projection room also cover the film preview requirements of the Network Centre.

Equipment for the editing and sync rooms has been transferred from Stockport Road, the previous home of the Film Unit.

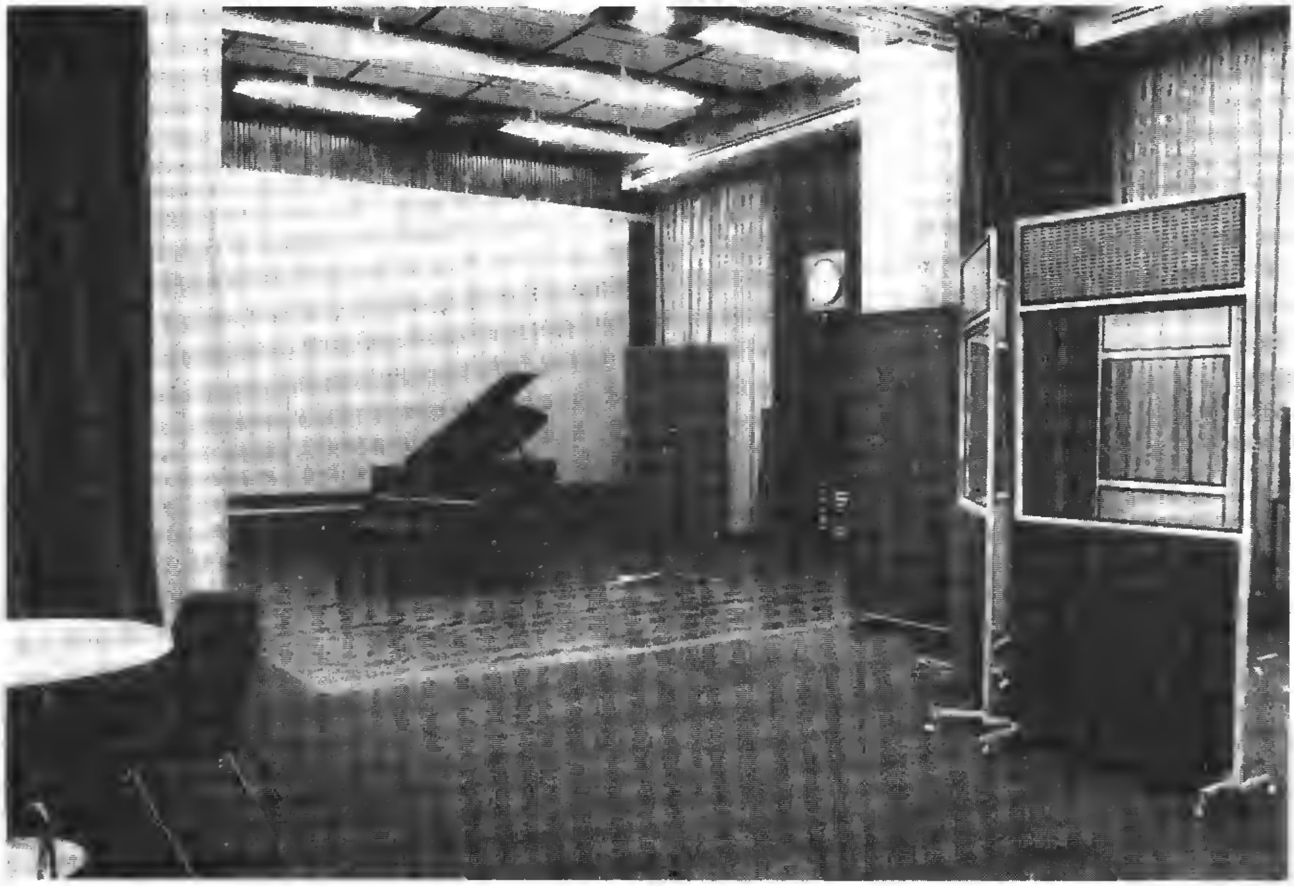


Fig. 6 Drama Studio 3 with its acoustic curtains partly drawn. The carpet of the 'live' section is retracted.

2 Radio studios

2.1 Network radio studios

The Studio 3 drama suite is the principal provision in terms of overall accommodation and range of facilities. It consists of a 128 metres[2] studio, its control cubicle and associated editing channel, a dead room and an area which serves the double purpose of narrator's cubicle or assembly area for artistes.

The studio design closely follows that of Studio 6A Broadcasting House, London, with live and dead sections. Retractable sections of carpet and suspended curtains across the centre of the studio provide control of the acoustics. The dead room is next to the dead section of the studio with direct access from it. Figure 6 shows part of the studio.

The desk in the control cubicle has BBC type D modules controlling four stereo, eight mono and two independent channels, with associated group controls. Ancillary facilities include compressors, limiters, response selection amplifiers, gramophone and tape machines.

The editing channel associated with the drama suite is equipped with a BBC-designed console, again with type D modules, incorporating mono and stereo inputs and outputs, echo facilities and tie lines to the central technical area. Three tape-editing machines have been transferred from existing premises. The editing channel can be used independently of Studio 3 and its cubicle.

Fig. 7 Talks Studio 4 from the control cubicle

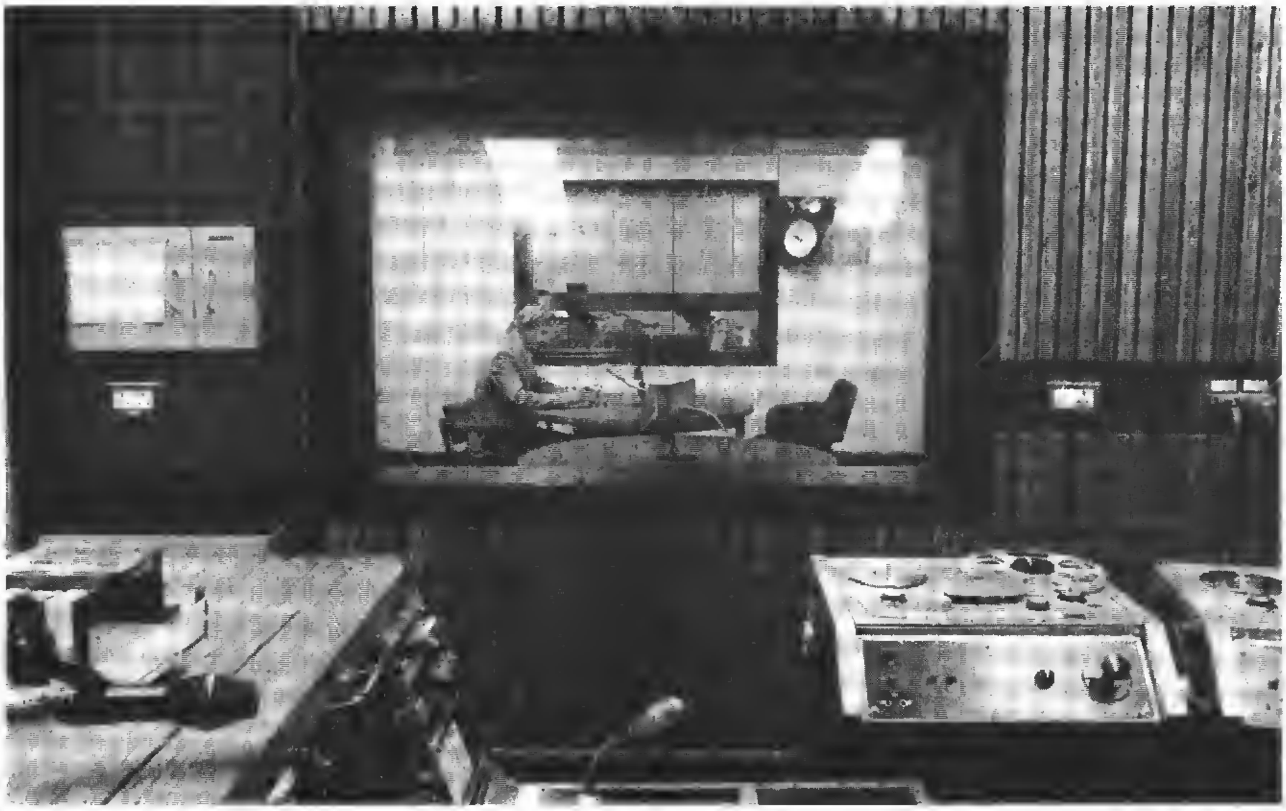


Fig. 8 Radio Manchester's Studio 1 with Cubicle 1B beyond, from Cubicle 1A. Each cubicle may be used alone or in conjunction with the studio, offering great flexibility for simultaneous rehearsal and transmission

Fig. 9 The larger of Radio Manchester's studios, Studio 2

The artistes' assembly area within the drama suite has observation windows into both studio and cubicle so that it can become a narrator's cubicle when required.

Figure 7 is a view of the talks/current affairs studio, Studio 4, from its control cubicle. The control desk incorporates a Neve BCM/10, ten-channel stereo mixer and a BBC-designed control panel which can handle eight outside sources. BBC-designed equipment for processing telephoned contributions to programmes is housed in a special trolley.

Studio 5, for network radio programmes, is very similar to Studio 4 with another Neve BCM/10 desk.

3 BBC Radio Manchester

A complete, newly-equipped, local radio station has been provided within the Stage I development for BBC Radio Manchester. The equipment and accommodation follow the principles most recently established with the Radio Carlisle station, and now known as the Mk III local radio station.

Studio I is flanked by two cubicles, IA and IB, either of which may be used with the studio or on its own (Figure 8). Two simultaneous operations are possible; for example, cubicle IA can originate a programme (with or without the studio) whilst IB is used for preparing or checking another programme. Studio 2, within the same suite, is larger than Studio 1 so that musical groups or a greater body of people can be accommodated. Studio 2 is complete with its own cubicle (see Figure 9). There is also a small news-inject studio near the local radio newsroom. The mixer desks in cubicles IA, IB and 2 are to a BBC design with 16 channels for controlling studio, and cubicle microphones, gramophones, tape and cartridge machines and outside sources.

The existing radio car for news reporting and outside broadcast work has been retained. A special parking position with battery-charging facilities has been allocated near the local radio reception area.

The local radio suite also has an editing room, gramophone/tape library, workshop and stores. The newsroom occupies a considerable area and has comprehensive telephone facilities, teleprinters and a small 'news cabin' where newsflash material can be originated.

4 The central technical area

As already mentioned in the Introduction, the central technical area embraces a large number of technical functions, some of which were described in detail in Section 1 (television facilities).

The central feature of the CTA is a desk (Figure 10) which has facilities for switching, routing and comprehensive monitoring of incoming and outgoing signals for radio and television. Communication with other technical areas is established through an engineering exchange (EMX).

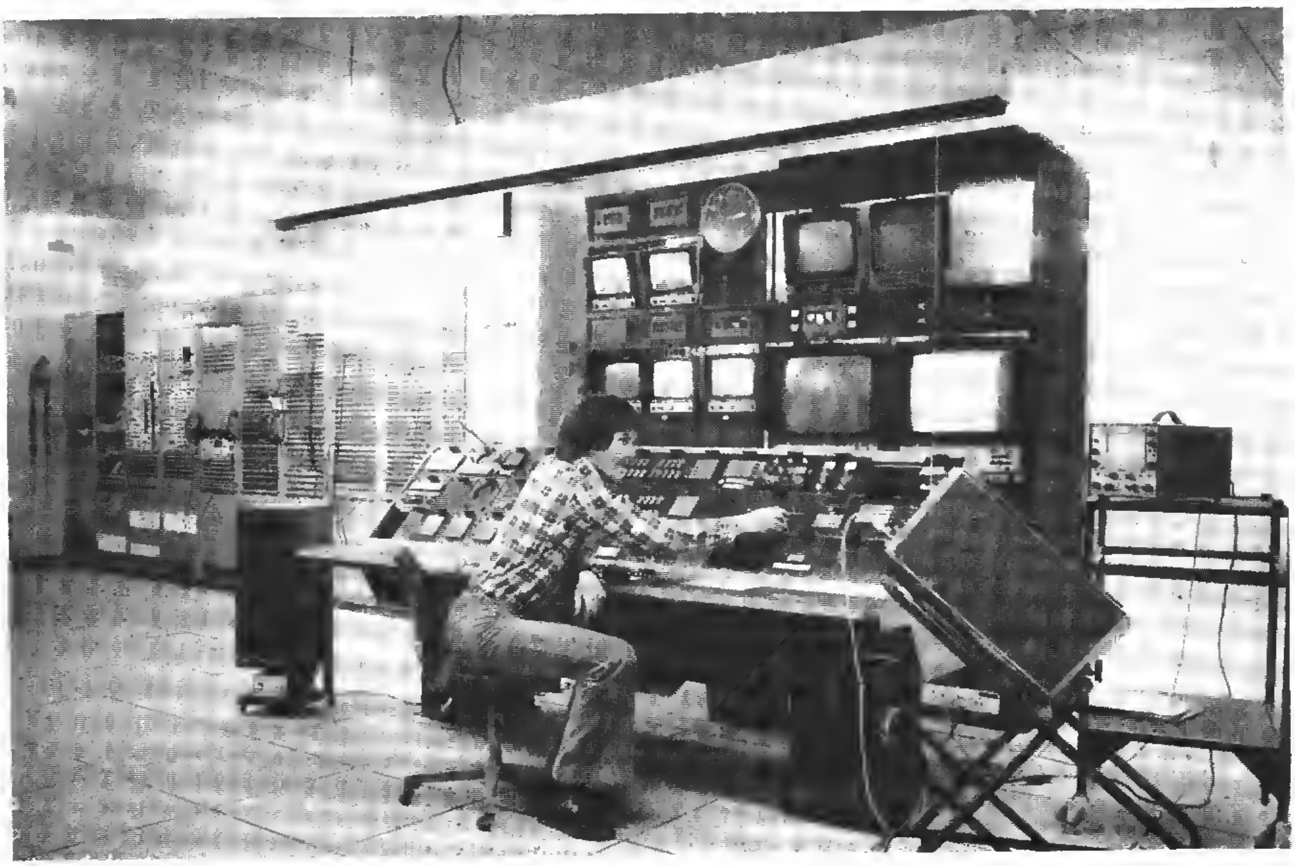


Fig. 10 The control desk in the Central Technical Area

Television programme sources and their related ancillaries are routed internally by means of a Rendar plugfield with 600 fully-equipped crosspoints (25 sources to 24 destinations). The plugfield controls a solid-state router matrix which has been wired to allow 25 sources to be routed to 30 destinations at some stage in the future. Married television sound is routed simultaneously with vision.

Two 625-line pulse chains provide the standard waveforms required for colour operation. They can be driven from a rubidium oscillator or from quartz crystal units. Each chain incorporates Natlock facilities, but only one has the full range of Genlock facilities. Sound-in-syncs decoding and encoding equipment has also been installed.

The CTA also incorporates the television apparatus room which contains all the vision equipment for Studio A. This section of the CTA has its own operational lighting and a folding curtain which control the monitoring conditions when cameras are being lined-up and checked critically for performance. The camera control units are rack mounted, not desk mounted as in previous installations.

Adjacent to the television apparatus section of the CTA are the apparatus bays of the 'Q-File' lighting control system, and the bays associated with the television studio sound communications system. The latter is a relatively new and sophisticated system based upon a solid-state matrix which allows great flexibility in source/destination interconnections throughout the television originating and operational control positions.

The CTA also contains lines termination and equalisation equipment, 48-kHz telecommunications and Post Office equipment bays.

5 Power supplies

The substation area, at lower ground floor level, consists of HV and MV switchrooms, together with a battery room. Nearby are the diesel alternator and technical battery rooms.

Two incoming 6600 volt feeders from the local Electricity Board are brought into the HV switchroom where automatic and manual changeover between feeders is possible. Vacuum circuit breakers are installed on the HV switchboard, this being a new departure for a main BBC building. The HV panels then feed four 660/433 volt, 3-phase transformers in the MV switchroom; two of the transformers are rated at 1000 kVA and the other two at 750 kVA. After passing through appropriate switchboards in the MV switchroom, power is fed to the various local switchrooms around the building.

The battery room in the substation area is provided for emergency lighting and fire alarm supplies. The standby diesel alternator provides a maintained supply, in the event of mains failure, to a number of critical areas, and has a load capacity of 100 kVA. The alternator set starts automatically after a mains failure and after a few seconds the following supplies are restored:

a. maintained lighting in essential operations areas
b. national network distribution equipment
c. local radio station
d. technical battery-charging equipment
e. PABX
f. telecommunications equipment in the CTA
g. minimal ventilation extract plant — fumes, battery, diesel alternator

A Portable Television Lighting Control System

P.E. Tipple
J. Froggatt

Manchester Network Production Centre

A novel form of lightweight, portable, television lighting control equipment has been devised and its advantages demonstrated in a prototype. Its most notable feature is that all operations are carried out with touch-operated switches and the panel therefore has neither vulnerable mechanical switches nor any other moving parts. These are important considerations in portable equipment which is expected to be reliable and to require minimal maintenance although it will be subjected to frequent manhandling.

Touch-operated switches are familiar nowadays, as television tuning controls for example, but it is believed that their use as the elements of a fader, as in this equipment, is new. The fader uses sixteen of them in ladder formation and the associated electronics are such that, as the finger is run up or down the fader, instantaneous digital signals are developed which ultimately represent the level selected by the last element touched.

A lighting balance may be stored in any of a number of memories (16 in the version shown in the photograph and 64 in the production prototype) known as preview stores. Each of these is capable of recording the levels for up to 48 luminaires. A memory is accessed by operating one of the numbered switches at the top left of the panel and its number is indicated in the 'preview' window. The first lighting channel (dimmer and luminaire) to be adjusted is selected by the switches shown above the operator's hand in the photograph and the channel number appears in the window above the fader. The fader is operated in the manner already described and the final level is indicated by the appropriate light-emitting diode in the column marked 'P' alongside the fader. Other channels are then called up in sequence and their levels set in the same way. New balances are recorded in different memories by repeating the whole process as many times as necessary.

A single store, the stage store, is used to control the dimmers and, thereby, the luminaires. Information in the stage store is caused to match that in any selected preset store by a cross-fade process. The rate at which the change takes place is governed by the fade-rate controller, the lowest row of switches on the left hand side of the panel. The fade rates are in seconds, 'C' being the 'cut' position, and it is only necessary to touch the appropriate switch to effect the change. Illumination of the relevant l.e.d. in column 'S' indicates its completion.

Whilst the stage store is in use, controlling the luminaires for a particular scene, a new balance can be recorded in one of the preview stores ready for transfer to the stage store.

The 'ADD' switch is used to add together the contents of two previous stores to form a composite balance. The 'A' switch (centre switch, top row, right) brings all of the channels on together for an arbitrary starting level of illumination whose level is set by a single operation of the fader; each channel is then adjusted individually to give the desired balance. If the two 'C' switches next to 'A' are touched simultaneously, the balance in one selected preview store is made identical to that in another.

The touch switch contacts are heavily gold plated for good conductivity and to resist corrosion. They are etched on to a sheet of copper-clad glass-fibre board similar to that used for conventional printed circuit boards. The sensitive contact is 1 mm wide and is separated from the adjacent earthed section by 1 mm channels which are filled with epoxy resin to prevent dirt from bridging the contacts. Digital control techniques, with CMOS low-consumption devices, have been used to minimise power consumption, and a simple battery/capacitor unit could obviate loss of memory caused by failure of the mains supply.

The equipment has been developed primarily for Outside Broadcast and small-studio use where operators have had to use simple forms of multi-potentiometer control, whereas their colleagues in larger studios have enjoyed the comprehensive facilities offered by sophisticated, computer-aided systems.

BBC/Post Office 120 Mbit/s Transmissions

General view of the equipment used during the experimental transmissions of digital television.

After pilot field trials in April 1975, the BBC and the Post Office carried out a major field trial at Portsmouth during October 1975 using equipment for digitally multiplexing two colour television and twelve high-quality sound-signals to form a 120 Mbit/s signal, which was transmitted over a new Post Office digital line system.

The 120 Mbit/s line system is an experimental system with terminals at Guildford, Portsmouth and Southampton; it uses coaxial cable with regenerative repeaters spaced at about 2 km intervals. The cable-type and repeater-spacing are the same as those used for existing 12 MHz frequency division multiplex analogue telephony-systems. The trials were conducted at the Portsmouth intermediate terminal point, so that it was possible to send signals to Guildford and back, to Southampton and back, or through the two paths connected in tandem. In the latter case a total of 106 regenerative repeaters were included in the overall transmission path, about 200 km in length.

The multiplex 120 Mbit/s input signal was generated in experimental equipment built in the BBC Research Department. It was formed by interleaving two similar 60 Mbit/s 'packages'. Each 60 Mbit/s package consisted of a multiplex of one digital PAL colour video signal with a nominal bit rate of optionally 44.3 or 53.2 Mbit/s and one 2048 kbit/s multiple signal for sound channels. The four signals in the 120 Mbit/s multiplex were not synchronised, i.e. their precise bit-rates were independent of each other and also of the resultant 120 Mbit/s bit-rate.

Each video channel employed sub-Nyquist sampling at a rate equal to twice the colour subcarrier frequency of the PAL signal (i.e. about 8.9 MHz). After quantising with 8 bits per sample, the bit rate was reduced to optionally 5- or 6-bits per sample, using a form of differential pulse-code modulation. The resultant bit-rate was 53.2 Mbit/s (a dummy sixth bit being used in the 5-bit option) which, after the application of Wyner-Ash convolutional error-correction coding, was increased to 56.8 Mbit/s.

The sound channels of 15 kHz bandwidths were coded using a 'near instantaneous' digital companding technique to enable six such channels to be fitted, with error protection, into a bit rate of 2048 kbit/s, which is the bit rate of the first-order multiplex in the new digital communications network under development by the Post Office. For the field trials, two of six sound channels in one of the 60 Mbit/s packages were equipped.

The chief purposes of the BBC/Post Office trials were to check that experimental BBC equipment could interface satisfactorily with that of the Post Office, and to enable the Post Office, the BBC and the manufacturers of the line systems to make observations on jitter and error performance — the two main sources of impairment which can arise in a digital transmission system.

All the systems and equipment under test were designed and built in the UK. The experiments were successful and they gave valuable practical experience, particularly with regard to techniques necessary to attain the desirable goal of a digital system able to transmit any arbitrary binary sequence.

UHF Triple-tone Generator

The BBC has recently introduced a portable, self-contained triple-tone generator which, when used in conjunction with a counter and spectrum analyser, enables the transposers at low-power uhf relay television stations to be adjusted for optimum performance.

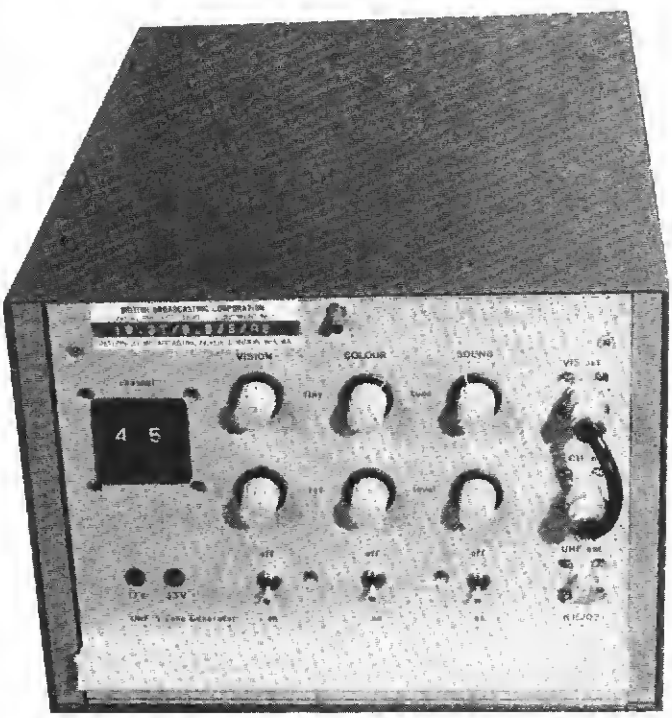
The new unit has sufficiently linear response to ensure that the intermodulation products arising from the simultaneous handling of the vision, sound and colour sub-carrier signals — in and out of channel — are kept to a minimum.

The three tone test signals operate at levels of −8, −7, and −17dB relative to the peak vision signal. The output from the generator is nominally −30dBm (7.1mV), flat to within 2dB from 520MHz to 800MHz, falling by about 10dB at the band edges.

The generator comprises three voltage-controlled oscillators, appropriately labelled vision, colour and sound, tuneable to any channel in Bands IV and V. The oscillators are tuned to the approximate frequency by thumb wheel switch, selected to the appropriate channel number, and fine tuned by means of a multi-turn potentiometer.

The outputs from the oscillators are adjusted to the right level by means of capacitive dividers and then combined in a resistive network. The vision oscillator output to the combining unit is routed via a U-link on the front panel for frequency checking purposes.

It is expected that the adoption of this relatively cheap, reliable unit throughout the BBC will enable the three-tone test technique to be introduced as a routine field procedure for performance checking at low-power uhf relay stations.



Brief Specification

Power requirements	240V 50Hz 10VA
Frequency range	Channels 21 to 68 (471MHz to 853MHz)
Output power	−30dBm into 50
Frequency stability short term (after 3 hours' warm up)	Better than 1 part in 10^5

Intermodulation products

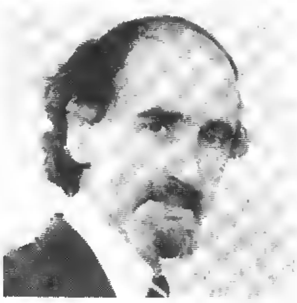
Frequency (MHz) wrt vision carrier	Level (dB) wrt peak sync
−6	better than −60
±1.57	better than −75
+2.86	better than −66
+7.57	better than −66
+12	better than −60

Contributors to this issue

Jim Elliot joined the BBC in 1944 and served as a technical assistant at the Brookmans Park transmitting station until transferring to the Television Service in 1946. He occupied various posts in television operations and in 1961 became a projects engineer with responsibility for specifying and accepting new engineering facilities. In 1969 he was appointed Head of Lighting and Mechanical Unit in the Studio Capital Projects Department and in the following year he became Project Manager, Manchester.

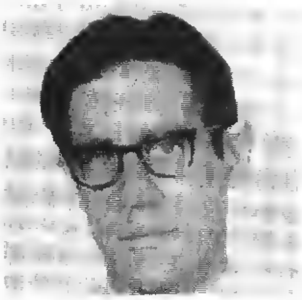
John Froggatt has been based at Manchester since joining the BBC in 1958 from the National Coal Board, where he was an electrical engineer. He travelled extensively during the late 'sixties in charge of the Roving Eye camera vehicle. Since 1968 he has been Electronics Maintenance Supervisor.

Dudley Harwood is a graduate of London University and joined the BBC Research Department in 1947 after spending some years in the Acoustics Section of the National Physical Laboratory. He has worked on problems associated with microphone and loudspeaker design and development and on the determination of factors involved in the engineering and subjective aspects of stereophony. He is at present responsible for the work on acoustic modelling and is also engaged on questions relating to quadraphony. He has written a number of monographs and other papers and has taken out a number of patents.



Ken Lansdowne joined the BBC in 1945 and worked at the Brookmans Park transmitting station and the Tatsfield frequency measuring station. In 1949 he joined the acoustic section of Research Department and in the last few years has worked mainly on acoustic modelling.

Donald Nimmy joined the BBC as a civil engineer in 1962 and became Chief Civil Engineer in the Architectural and Civil Engineering Department in 1971. In this post he has been responsible for the construction of masts and towers and the transmitting station building programme, both in the United Kingdom and overseas, together with mechanical services systems in all BBC premises. He is Chairman of the BBC's Energy Saving Working Group.



Kenneth ('Ted') Randall joined the BBC from school in 1944 as a youth-in-training at a transmitting station, later transferring to London Recording Unit. After two years spent in the REME and a short time with Cable and Wireless Limited, he rejoined the BBC at the Skelton short-wave transmitting station. In 1950 he transferred to the Research Department where he is at present in the Physics Section. He has been engaged mainly on acoustic problems encountered in sound and television studios.

Bob Sparks joined the BBC in 1953 from private architectural practice following experience in the Ministry of Works on Post Office buildings. He qualified as an architect in 1950 and was elected an Associate of the Royal Institute of British Architects in 1951 and a Fellow of the Royal Society of Arts in 1964. Appointed a Senior Architect in 1963, he was involved in many of the Television and Radio developments in London area and was entirely responsible for all work in the London area as Head of London Building Section from July 1968. In his present position as Chief Architect, to which he was appointed in January 1970, he is responsible for all architectural design and construction work on studio and office premises required by the BBC throughout the country.

Paul Tipple joined the BBC as a technical assistant in 1967. He worked for two years in the film recording area at Television Centre, where he was involved in the automation of part of the recording process. Since 1970 he has been a member of the Communications and Engineering Services section at Manchester, where his work has included the development of a small studio thyristor lighting installation and a control system for slide projectors.